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ABSTRACT

This document is intended to help high school vocational-technical teachers design courses that result in high-quality learning for all their students. The book's seven chapters detail this process for designing courses that achieve the following results: model the concept of quality; produce independent learners; develop active participants in the learning process; address real problems in life and the workplace; confront students' shortcomings and show them how to improve; present challenging assignments requiring hard work in and out of the classroom; actively involve students in productive learning throughout the class period; require student teamwork with teachers serving as coaches rather than as the source of knowledge; and prepare youth for work and further education beyond high school. Chapters 1-7 discuss the following topics: (1) the need for change; (2) a new vision of quality vocational-technical education; (3) the vocational-technical program of study; (4) the issues involved in designing a course (content as a function of expectations of career areas; providing a focus for learning; teachers as managers of instruction; communities as learning labs; continuous assessment); (5) planning and setting course goals; (6) projects and instructional strategies; and (7) assessment. The following items are appended: course syllabus guidelines; a sample course syllabus; national skill standards; and project outlines. (MN)

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A Guide to Preparing a Syllabus

DESIGNING CHALLENGING VOCATIONAL COURSES

Gene Bottoms, David J. Pucel and Ione Phillips

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A Guide to Preparing a Syllabus

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Gene Bottoms, David J. Pucel and Ione Phillips

Southern Regional Education Board

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Table of Contents

Introduction 2

Chapter 1. The Need for Change 4

Chapter 2. A New Vision of Quality Vocational-Technical Education 14

Chapter 3. The Vocational-Technical Program of Study 20

Chapter 4. Designing a Course: An Overview of the Issues 28

Chapter 5. Designing a Course: Planning and Setting Goals 35

Chapter 6. Designing a Course: Projects and Instructional Strategies 45

Chapter 7. Designing a Course: Assessment 67

Conclusion 88

Appendix A – Course Syllabus Guidelines 89

Appendix B – Sample Course Syllabus 92

Appendix C – National Skill Standards 98

Appendix D – Project Outlines 105

Introduction

High Schools That Work is committed to high-quality vocational studies. The purpose of this book is to help high school vocational-technical teachers design courses that result in high-quality learning for all of their students. In doing so, vocational educators will need to expect more of their students. They will also need to develop courses and use teaching methods to help a wide range of youth meet higher expectations and prepare for future education and a career.

This book is designed to change how vocational courses are taught and what is expected of students enrolled in them. If students are asked to work hard to achieve high performance goals, their courses must:

- Model the concept of quality;
- Produce independent learners;
- Develop active rather than passive participants in the learning process;
- Result in quality products that address real problems in life and the workplace;
- Confront students' shortcomings and show them how to improve;
- Contain challenging assignments that require hard work in and out of the classroom;
- Actively involve students in productive learning throughout the class period;
- Require student teamwork, with teachers serving as coaches rather than as the source of all knowledge;
- Prepare youth for work and further education beyond high school.

Vocational teachers are equal partners with academic teachers in providing a total learning experience for high school students. This book will show vocational teachers how to enrich the vocational curriculum so that students use academic and technical content to complete intellectually challenging assignments.

Focusing on career majors will attract a wide range of students to vocational studies. But these majors must be much more than a re-packaging and re-labeling of the traditional vocational curriculum; they must consist of courses that prepare youth for employment, postsecondary education and professional-level studies, depending upon students' interests and goals. Whether students go to work immediately after high school or continue their formal education, they must be equipped with the intellectual, academic, technical and personal skills needed to learn and advance.

This book offers a blueprint for vocational teachers as they:

- Set challenging learning goals for students;
- Revise goals for vocational courses;
- Plan assignments that require students to use technical and academic knowledge and skills;
- Determine the content of vocational courses in the context of a career major or concentration;
- Define how courses should be delivered to ensure students' success in meeting quality standards;
- Develop assessment strategies that hold students accountable for achieving quality learning.

The following chapters will contain the steps to be taken and will provide assistance in developing a syllabus that meets the goal of raising the achievement of career-bound youth[1].

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[1] The Southern Regional Education Board defines career-bound youth as high school students who plan to work, attend a two-year community college or vocational school, participate in an apprenticeship program, or enter the military after high school graduation. Career-bound students are not planning to enter a four-year college or university but may make that decision at some future time.

Chapter 1

The Need for Change

Why should vocational courses be different today? The answer is simple. Today's workplace is quite different than in the past. This nation has moved from an industrial era to an information age—from a domestic to a global economy. Youth must be prepared for a new world and the dramatic changes taking place in what workers are expected to know and be able to do. There is a new contract between employees and their employers. The old contract promised, "If you work hard and do your job well, the company will take care of you." The new contract says, "If you have the skills the company needs in a changing economy, you will have a job."

The burden of maintaining employability falls to the individual, not the company. It is not unusual for a company to terminate an unskilled worker and hire someone whose skills have kept pace with change.

The Way It Was

In the past, employees were expected to do only what their supervisors told them to do or showed them how to do. Typically, workers were asked to perform a series of procedures to complete narrowly-defined business or industrial tasks. Managers, engineers and supervisors made the decisions, and workers carried them out. Employers decided when workers needed new skills and provided training programs in those areas. Employees didn't think for themselves or suggest better ways to do a job.

How It Is Now

Today, employees still need to be able to handle procedures related to their jobs, but this ability is not sufficient for success. Workers are expected to participate in teams to suggest ways to improve how things are done. They are expected to learn new skills quickly and to take much of the responsibility for developing new skills.

A Story About John and Mary

John and Mary are both hired by a company producing computers. Each has completed a vocational program in automated manufacturing but at different schools.

John works hard and does what his boss tells him to do. When his boss asks him how he would change the work processes, he defers to the boss to make the decisions. As new skills are needed, he takes part in the company's training programs.

Mary also works hard and does what her boss tells her to do. When the boss asks how she would change the work processes, she makes suggestions and knows why she is making them. She observes changes in the company and the direction the company is going. In addition to participating in the company's training programs, she takes other courses to develop skills she thinks will be needed in the future. She applies the new knowledge as she makes suggestions for changing company processes.

Which of these two employees would you prefer if you were an employer? Which vocational program do you think will get more support? If the company downsizes, which employee do you think will be kept on the payroll?

The Challenge for Vocational Education

High school vocational education must change if the goal is to help students become productive employees. The focus on procedural skills and "monkey see, monkey do" instruction that was sufficient to prepare workers for factories, offices and other work settings in the past is no longer appropriate. With the current demand for workers who can make decisions and learn independently, students need a different mix of educational skills.

Administrative assistants are a good example. In modern offices, it is no longer enough to be able to type, take messages and perform simple tasks. Office employees must be able to make and implement wise decisions, operate and trouble-shoot complex computer systems and answer questions based on judgments they make. They are expected to cooperate with others and to suggest ways to improve the work flow.

Yet, high school vocational courses may fail to prepare students to assume expanded roles in the workplace. Responses from more than 6,000 vocational

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teachers at more than 550 *High Schools That Work* sites participating in a 1996 survey of secondary teachers revealed that only one-third of the teachers (35 percent) felt they could recommend 60 percent or more of their students as being highly competent in an area of specialization.

Many vocational teachers who doubt that their students can meet high academic and technical standards have become victims of their own low expectations. These teachers and their schools have not established procedures to ensure that students know what is expected of them in vocational courses and have not involved parents in students' decisions to enroll. As a result, many students take vocational courses to escape from something else. In the desire to maintain student enrollment, many vocational teachers have been content to ask very little of their students. When these conditions prevail, few students perform well.

Society has a right to expect far more from high school vocational education. Vocational educators can play a leading role in developing meaningful career majors that will enable students to explore and prepare for further study and careers. Vocational leaders and teachers need to plan integrated school site and work site learning that will help students blend academic, technical, thinking and personal skills. Students must be able to use problems, products and issues from the modern workplace to make learning authentic and meaningful.

High Schools That Work surveys of graduates, students, teachers and employers point to the need for drastic changes in how vocational education is structured and delivered. This chapter explores some of these findings.

What Do Vocational Graduates Think of Their Experiences?

In a 1996 follow-up survey of more than 2,500 students who completed vocational studies at *HSTW* sites in 1994, 36 percent said their vocational teachers should have placed more emphasis on meeting higher standards and expectations. When asked if their schools should have placed more emphasis on vocational and technical programs, a full 75 percent of graduates agreed. Seventy-one percent said they should have been required to meet higher academic standards. These youth also said vocational teachers should have placed more emphasis on getting students to use mathematics concepts in vocational courses, on having them to read and interpret technical books or manuals, and on requiring them to write technical reports and business letters. Responses to similar questions were fairly consistent. Graduates believe high schools should place more emphasis on vocational and technical programs, provide more demanding learning experiences and establish higher course requirements. (See Table 1.)

Table 1
Vocational Graduates' Attitudes Toward Their High School Experiences

	Agree Strongly	Agree Somewhat
I should have worked harder in school.	49%	34%
I should have been required to meet higher academic standards.	29%	42%
School should have placed more emphasis on mathematics.	25%	51%
School should have placed more emphasis on science.	15%	42%
School should have placed more emphasis on reading.	24%	43%
School should have placed more emphasis on verbal communication.	33%	47%
School did not offer enough practical work experience.	26%	36%

	More Needed	Right Amount	Less Needed
How do you feel about the emphasis vocational teachers placed on showing how mathematics is used in vocational areas?	33%	63%	4%
How do you feel about the emphasis vocational teachers placed on reading and interpreting technical books and manuals?	34%	61%	5%
How do you feel about the emphasis vocational teachers placed on writing technical reports, service reports and business letters?	37%	57%	6%

How Do Students' and Teachers' Perceptions of Vocational Programs Differ?

Major discrepancies exist in what vocational students and their teachers say happens in vocational classes. For example, the 1996 *HSTW* teacher survey revealed that most vocational teachers believe students are being required to use academic knowledge and skills to complete vocational assignments. However, fewer than half of students participating in the 1996 *HSTW* assessment said they had been asked to use academic skills in vocational courses. Teachers and students agreed that little effort is needed outside of class to pass a vocational course. More than 6,000 vocational teachers and approximately 17,000 vocational completers[2] were surveyed. (See Table 2.)

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[2] *High Schools That Work* defines a vocational completer as a 12th-grader who is completing at least four courses in a vocational concentration.

Table 2

Perceptions of Vocational Programs by Teachers and Students Participating in the 1996 *HSTW* Assessment

	Vocational Teachers	Vocational Students
The importance of the following subjects is frequently stressed in vocational classes:		
■ Reading	92%	44%
■ Writing	71%	46%
■ Mathematics	75%	57%
■ Science	NA	33%
The following subjects are used daily or weekly in completing vocational assignments:		
■ Reading	69%	49%
■ Mathematics	81%	48%
Students spend more than two hours weekly on homework for vocational classes.	11%	5%
Students present assignments to the class.	26%	9%
Students use computers to complete assignments.	52%	45%

The difference in opinion presents a challenge to vocational teachers who want to raise course standards and adopt teaching practices to ensure student success. Vocational teachers' answers to questions concerning changes in school practices since the school became a *High Schools That Work* site reveal the extent of the challenge. Large percentages of teachers said they had seen no increases in:

- Expectations for student performance;
- The use of learning activities that involve academic content;
- Joint projects with other teachers;
- The amount of homework assigned;
- The use of hands-on experiments or projects.

Visits to *HSTW* sites often reveal situations in which students are neither being challenged nor expected to do minimum amounts of work. The following observation from a technical assistance visit to one *HSTW* site is typical of the type of situation that should not be tolerated in vocational classes:

"In vocational labs at this school, we saw a few students completing fairly complicated assignments. However, a lot of students were simply hanging out and having fun. In other words, if you want to learn, you can. But if you don't want to learn, you can do nothing and pass."

How Well Do Vocational Completers Perform?

The 1996 *HSTW* assessment provided ample evidence that *HSTW*-recommended strategies can make a significant difference in student success. The reading, mathematics and science tests administered to vocational completers in the *HSTW* assessment are based on the National Assessment of Educational Progress (NAEP)— the assessment that helps the National Center on Education Statistics produce "the nation's report card." Unlike most national standardized tests, the *HSTW* assessment contains many open-ended items for which students must construct responses.

The average scores for vocational completers at *HSTW* sites increased in all three test categories— reading, mathematics and science—between 1994 and 1996. High-performing sites—those with scores in the top 25 percent of all *HSTW* sites—actually posted scores that exceeded the *HSTW* goals in reading, mathematics and science. (See Table 3.) Even more encouraging is the fact that the average scores of students from all *HSTW* sites exceeded the average scores of a national sample of vocational students who took the NAEP exams. (See Table 4.)

Despite the increase in scores between 1994 and 1996, much work remains to be done. NAEP has established four levels of performance on its tests. The two top levels—proficient and advanced—represent desirable achievement goals.

Table 3

Vocational Completers' Average Scores in the 1996 *HSTW* Assessment

	Reading	Mathematics	Science
All *HSTW* Sites			
1996	273	285	283
1994	264	281	282
National Vocational Students	267	277	267
High-Achieving *HSTW* Sites			
1996	287	303	294
***HSTW* Goal**	**279**	**295**	**292**

Table 4
Percentages of Students Who Scored at Proficient and Advanced Levels

	High Schools That Work		National	
	All Sites	High-Achieving Sites	Vocational	Academic
Reading				
Proficient (304)	12	22	10	44
Advanced (348)	<1	<1	<1	6
Mathematics				
Proficient (300	36	52	21	60
Advanced (350)	2	5	2	12
Science				
Proficient (300	28	42	18	48
Advanced (350)	<1	<1	<1	12

Note: The number in parenthesis is the minimum score (on a scale of 0-500) for the level.

In all cases, vocational students scored well below their academic counterparts on the tests. However, more than half of the students at high-achieving *HSTW* sites reached the NAEP "proficient" level in mathematics. (See Table 4.)

HSTW awards a Certificate of Educational Achievement to youth who meet or exceed the *HSTW* goals in all three areas and complete three of four recommended curriculum goals. (See page 26 for the *HSTW*-recommended curriculum for career-bound high school students.) In 1996, 17 percent of students at *HSTW* sites qualified for the certificate. Earning a certificate brings an additional benefit to students. In 1997, the BellSouth Corporation invited youth who earned this certificate as seniors in 1996 to apply for positions with the company. Of the 73 youth who accepted the invitation, 70 passed the BellSouth employment exam. All of them were invited to take the technical exam and those who passed were offered a job with the company. As a result, BellSouth and other companies are taking another look at recent high school graduates as potentially productive employees. These companies are discovering that youth who worked hard and had a career focus in high school can merit a job and assistance with further education.

Significant differences exist in the performance of students on the *HSTW* assessment by vocational area. Drafting and design students had the best scores overall; they had the highest average scores in mathematics and science and the third highest scores in reading. Business, marketing and computer students had the highest scores in reading. Other fields that had among the highest average scores were electronics and communications. Health students scored well in reading. Students in home and commercial repair and construction had the lowest reading scores. Cosmetology and family and consumer sciences students had the lowest average scores in mathematics and science. (See Table 5.)

When average scores are compared to the *HSTW* reading, mathematics and science goals,[3] only a very small number of vocational areas measured up. They include:

Reading — Students in business, marketing and computers met the *HSTW* goal.

Mathematics — Students in drafting and design and electronics met the *HSTW* goal.

Science — Students in drafting and design met the *HSTW* goal.

Table 5

Performance of Students by Vocational Program in the 1996 *HSTW* Assessment

	Percentage Tested	Reading Score	Mathematics Score	Science Score
Agriculture	9	267	284	286
Business, Marketing, Computers	37	279	290	282
Family and Consumer Sciences	9	269	269	270
Industrial and Manufacturing	5	262	280	284
Transportation	7	260	280	284
Home and Commercial Repair	1	258	273	280
Health	10	278	283	281
Communications	2	276	290	289
Electronics	5	269	295	292
Cosmetology	3	267	268	270
Construction	4	260	282	283
Community Protection	1	270	283	283
Drafting and Design	5	276	306	296
Other	2	272	288	285

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[3] The *High Schools That Work* goals are 279 in reading, 295 in mathematics and 292 in science. Students who achieve the reading goal on the *High Schools That Work* Assessment are able to read and interpret a variety of materials, find and organize information and construct written and oral responses to materials read. In meeting the mathematics goal, students demonstrate that they can compute with decimals, fractions and percentages; recognize geometric figures; compute area and volume; recognize relationships among units of measurement; solve simple equations; and use moderately complex mathematics reasoning. In science, students who achieve the goal can evaluate the design of an experiment, apply scientific knowledge to their personal lives, retrieve and interpret information from text and graphs and demonstrate an understanding of key life and physical science principles.

Table 6

Percentages of Students Who Met the *HSTW* Goals By Vocational Program

	Reading Percentage	Mathematics Percentage	Science Percentage
Agriculture	36	44	44
Business, Marketing, Computers	53	48	37
Family and Consumer Sciences	35	27	21
Industrial and Manufacturing	29	39	39
Transportation	25	38	39
Home and Commercial Repair	19	31	33
Health	52	40	34
Communications	45	50	50
Electronics	38	54	53
Cosmetology	26	24	18
Construction	27	39	39
Community Protection	41	39	38
Drafting and Design	46	68	61

Overall, 26 percent of vocational completers met all three performance goals. Within each vocational area, the percentage of students who met the goal ranged from a high of 68 percent of drafting and design students who met the mathematics goal, to a low of 18 percent of cosmetology students who met the science goal. (See Table 6.)

It is clear from the assessment results that more work is needed by both vocational and academic teachers to get more vocational students to meet or exceed the *HSTW* goals.

What Do Employers Say?

Employers confirm many findings from the *HSTW* assessment of graduates, teachers and students. In 1996, *HSTW* surveyed 799 employers who had hired vocational graduates. The participants were asked to rate the importance of general competencies and foundation skills in terms of a skill's importance to the job and the proficiency of vocational graduates in using each skill. A total of 193 employers responded to the survey. Findings showed that high school graduates in their first jobs are deficient in many skills considered vital in the workplace. These attributes are in the areas of interpersonal, learning, communication and problem-solving skills and personal responsibility. (See Table 7.)

Table 7
Employer Ratings of Vocational Graduates' Proficiency Levels

Skill	High Importance to Job + *Percentage*	Superior Level of Proficiency * *Percentage*
Interpersonal		
Team member	73	54
Serves customers	65	45
Information		
Acquires and evaluates information	51	41
Interprets and communicates information	57	39
Academic Skills		
Mathematics	39	32
Science	13	13
Reading	51	41
Writing	39	34
Listening	77	49
Speaking	62	42
Thinking Skills		
Creative thinking	36	28
Decision making	37	24
Problem solving	42	28
Knowing how to learn	66	44
Personal Qualities		
Responsibility	79	57
Self-management	63	44
Integrity/honesty	87	74

+ Percentage of employers who said the skill is of high importance in a job.

* Percentage of graduates whose proficiency was ranked as superior by employers.

Summary

A wealth of survey data indicates that vocational completers are failing to measure up in many areas that are critical to their future success. These youth are seriously deficient in their grasp of academic content and their demonstration of important thinking and personal skills. Through changes in course content and instructional and assessment strategies, vocational teachers can help students gain essential knowledge, skills and understandings.

Chapter 2

A New Vision of Quality Vocational-Technical Education

High Schools That Work has established a vision of what constitutes a quality learning experience for all high school students. This vision is expressed through 10 key practices that *HSTW* challenges all educators to follow. The vision of quality vocational studies—as defined by the key practices—includes the following:

1. ***Setting high expectations and getting students to meet them.***

Vocational teachers can set high standards and use teaching methods that motivate students to meet them. Over the past two decades, many vocational education programs have "accommodated" students who were believed to be apathetic or unable to perform. Therefore, many vocational-technical classes lack high standards that students must meet to get credit for the course. Such classes enable students to earn credit by doing low-level activities and "marking time." Quality vocational programs are characterized by well-defined expectations and teachers who help students achieve demanding goals.

2. ***Increasing access to challenging vocational studies, with a major emphasis on using high-level mathematics, science, language arts and problem-solving competencies in the context of modern business and technical studies.***

Vocational teachers can teach the skills and share the information their students need for continued learning, both in the new workplace and in further education. This means going far beyond teaching technical skills. Students need opportunities to develop intellectual and personal qualities by applying relevant academic and technical knowledge and skills in solving problems they are likely to encounter in the workplace. Students need to be able to solve problems, process information, communicate, work in teams, relate to customers, accept responsibility and learn independently.

3. ***Increasing access to academic studies that teach the essential concepts from the college preparatory curriculum through functional and applied strategies that enable students to see the relationship between course content and future roles they may envision for themselves.***

Many students enrolled in vocational programs may not be successful in high-level academic courses unless they are able to connect the content to problems, projects and issues beyond school. School-based and work-based vocational studies can become the organizing focus that gives purpose and meaning to high school academic studies for career-bound students. This outcome will not occur unless vocational teachers take the time to build bridges of communication and understanding with academic teachers.

To advance the academic achievement of career-bound youth, academic teachers can assign real-world problems and projects, not contrived ones. Vocational teachers—an excellent source of information on such experiences—can help their academic colleagues discover authentic strategies and help them see how to use relevant situations to show how academic knowledge is applied in real life. In addition, vocational teachers can be constantly alert to the academic deficiencies of their students and can work with academic teachers to correct these deficiencies.

4. ***Having students complete a challenging and related program of study, including four courses in college preparatory English, three courses in social studies, three courses in mathematics and three in science. At least two credits each in mathematics and science should be equivalent in content to courses offered in the college preparatory program. Career-bound students should also complete at least four courses in a vocational major and two courses in related areas.***

Vocational teachers can no longer pay attention only to what happens to students in vocational courses. Vocational graduates are also judged on their academic skills. Academic courses cannot be the "watered down" versions offered to vocational students in the past. *Vocational educators are responsible for making sure that their students take the right academic courses—such as algebra, geometry, chemistry, physics and high-level English—that will prepare them to be productive workers and lifelong learners.*

Without the knowledge base that these courses provide, students will not gain the in-depth understanding of mathematics, language arts, science and social studies needed for continued growth in all career fields. Vocational educators can work with curriculum development specialists to set graduation requirements that meet the criteria for a challenging program of study, including strong content in academic as well as vocational areas.

5. ***Providing career-bound students access to a structured system of work-based learning that is planned in collaboration with high-status school-based learning—high school and postsecondary—and that results in industry-recognized credentials and employment in a career pathway.***

The ultimate goal of high school vocational education programs is to help students begin the journey toward a successful career. Students should have a range of job-shadowing experiences and, ideally, planned internships in work settings related to career goals. Teachers need to know where their students are working, establish a system for employers and teachers to exchange information about students' progress and give students assignments that involve problems encountered in the workplace.

Academic and vocational teachers can work together to use workplace experiences to advance school-based academic and technical studies. In the past, vocational teachers have seen the workplace primarily as a link to their courses. Now it is important for them to see it as a rich source of ideas for relating academic studies to real-life situations. Involve academic teachers in this exploration so that they can discover authentic problems to use in teaching academic knowledge and skills.

6. ***Having an organizational structure and schedule giving academic and vocational teachers time to plan and deliver an integrated curriculum aimed at teaching high-quality academic and technical content.***

It is not surprising that academic and vocational teachers generally have not connected their content in meaningful ways. Physical and organizational barriers often keep teachers apart. Yet, the *HSTW* assessment reveals that career-bound students learn more when vocational and academic teachers plan joint learning projects.

For example, almost half of the students at schools participating in *HSTW*'s Advanced Integration Model (AIM) project met the *HSTW* performance goals in reading and mathematics, while 40 percent met the goal in science. In these schools, students reported spending more time doing vocational assignments that required them to acquire and evaluate information, do more homework, make oral presentations regularly, and complete challenging projects by using technical, academic, thinking and personal skills. Vocational teachers can break down barriers by reaching out to academic teachers to plan projects and units that link academic and vocational content. For this change to occur, teachers need encouragement and time to plan together.

7. ***Having each student actively engaged in the learning process.***

Real learning occurs when students struggle with difficult assignments. Active learners clarify what they need to know to complete a project; they think through a problem and work independently to solve it.

8. ***Involving each student and his/her parents in an individualized advisement system aimed at ensuring that each student completes a challenging and coherent program of academic study with a vocational or academic major.***

Good guidance practices are essential to motivate students. Students who choose vocational courses related to future goals are more highly motivated than students who choose what they believe to be the easiest courses accepted for graduation. Parents need to understand the choices available to students and

Polytechnic Advisement Support System (PASS) Scores High with Students, Parents and Teachers

When Kent Polytechnic High School in Woodside, Del., introduced the new PASS Program to teachers, some were not sure it would work. Today, all participants think it is one of the more positive things the school has ever done. PASS (Polytechnic Advisement Support System) is the school's way of making sure all students and their parents get the best possible advice about careers and educational plans.

In a nutshell, the program makes all staff members—administrators, teachers, counselors, the school superintendent and the principal—advisors to groups of approximately 10 students each. Staff development is provided to prepare faculty and administrators. Advisors work with the same group of students throughout their high school years to help youth and parents make informed decisions about education and future goals.

The advisor meets with each student three to eight times a year to help him or her set goals and develop a six-year plan (four years of high school and two years after graduation). The culminating event occurs in March each year when school is closed for a day and students come in with their parents for personal meetings with advisors to discuss course selections for the following year and to review the six-year plans. Ninety-one percent of students' parents showed up for the sessions in 1997. If parents cannot attend on the scheduled day, advisors work with them to set up other meeting times. Advisors visit students and parents at home if necessary.

A survey of parents showed that 96 percent found the meeting very beneficial. Teachers say students are much more focused on educational and career plans since the program began.

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participate actively in determining the best options. Vocational teachers can insist that students and parents visit a vocational program and talk with teachers before enrolling.

9. ***Providing a structured system of extra help to enable career-bound students to successfully complete a challenging program of study that includes high-level academic content and a career major.***

Students and teachers need to accept the fact that most students will have to make an effort outside of class to meet high standards in vocational courses. When vocational standards are raised, many students need extra help. A quality vocational program offers built-in opportunities for students to meet with teachers after class to get assistance with assignments. Teachers can make it clear to students that sub-standard work will have to be redone by focusing on weaknesses identified by the teacher. Unless students are told when their work is unacceptable, they will never learn to do quality work.

10. ***Using student assessment and program evaluation information to check and improve the curriculum, instruction, school climate, organization and management.***

The primary purpose of student assessment and program evaluation is to inspire student and teacher improvement. Students can experience the pleasure and pride of meeting high standards only if they are asked to do so. Programs and students can get better only if they are regularly measured against benchmarks of success. Educators can use the *HSTW* data presented in Chapter 1 to learn more about what teachers, students, other educators and employers think about vocational education. They can also ask local groups how well the school is doing in preparing career-bound youth and what should be done to improve students' performance.

Realizing the Vision

The *HSTW* key practices provide new definition and much higher standards for high school vocational-technical education. To achieve this new vision, educators will have to change their curriculum and instructional practices. Quality learning today calls for students to master a range of related academic, technical, intellectual and personal skills. All teachers must be part of a team that works to achieve this goal. *Quality vocational-technical programs* reinforce academic standards and provide authentic contexts for making learning meaningful. *Quality academic programs* reinforce vocational standards and use real-world problems to make learning more meaningful.

Concepts of Quality Vocational-Technical Education

Old	New
Stand-alone programs taught occupational skills for specific jobs.	Vocational education is part of a total program of academic and technical studies that prepares students for continued learning in work or educational settings.
Students were taught low-level related academic courses.	Students are expected to complete high-level academic courses.
All content needed for a career was taught by a vocational instructor.	Vocational and academic teachers work as an instructional team.
Programs focused on preparing students for entry-level jobs.	Programs focus on preparing students for further learning and a career pathway.
Program success was measured by the number of students who entered a specific occupation (for which they had prepared) immediately after high school.	Program success is judged by the number of students who make a successful transition to work, further study or both.
Most students went to work following high school graduation.	Most students plan to work and pursue further education beyond high school.
Vocational education was often equated with less able students.	Vocational education is part of the education of many students with a wide range of abilities.
Vocational educators "accommodated" many students by setting low standards.	Courses have challenging, clearly-defined goals that all students are expected to achieve.
Vocational education was an elective.	All students complete either an academic or a career major.
Academic educators viewed vocational education as a way to teach occupational skills to students who could not succeed in academic courses.	Academic and vocational educators work together to help students learn high-level academic and technical concepts.
Emphasis on learning procedural skills and following directions made students dependent on someone else to do the thinking.	Emphasis is on helping students become independent learners who can think through problems and find solutions.

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Chapter 3

The Vocational-Technical Program of Study

Implementation of a vocational curriculum that lives up to the *High Schools That Work* vision requires a clear understanding of the total high school curriculum. It is within this context that specific vocational instructional practices need to change. Let's start with a definition of terms:

Curriculum — The set of programs or courses offered by a high school.

Program — Each subject area in a high school curriculum—for example, mathematics, science, language arts, social studies and vocational programs.

Career Cluster — A broad career category that can encompass a variety of career or vocational majors. Many schools offer a choice of four or five career clusters—for example, engineering and science-related occupations; manufacturing and production-related occupations; business, marketing and management occupations; and health occupations.

Career Major — A program of study that includes a group of vocational courses focusing on a particular occupational family or career field. For example, a business, marketing and management cluster might include majors in management, finance, marketing or computer network systems; an engineering and science-related cluster might include majors in chemical technology, earth and atmospheric technology, mechanical technology or electromagnetic technology; and a health occupations cluster might include majors in health diagnostics, health therapy or health support.

Course — A subject taught within a program—for example, algebra within mathematics, physics within science and introduction to microcomputers within vocational-technical education.

Competency — A major concept, understanding, procedure or body of knowledge that a student learns as part of a course. *To master a competency, a student must be able to explain it, apply it, verbalize it and analyze it.* Students in a beginning electronics course might be asked to learn the application, mode of operation and construction of resistors in compliance with service manual documentation.

Program of Study — The array of courses a student takes in high school, including courses from programs such as mathematics, science, language arts, social studies, art, foreign language and vocational-technical education. The ideas, concepts, methods of inquiry and procedures taught in all courses should reinforce one another.

Planning Vocational-Technical Programs

The planning process for high school vocational-technical programs consists of identifying career clusters and majors and identifying the courses to be included in each major.

Identify the career clusters and majors to be offered as part of the total high school vocational program.

A high school vocational program consists of a number of occupational or career clusters; each cluster contains an even larger number of career, vocational or academic majors. Vocational and academic courses are grouped to form career majors in much the same way that college courses are grouped. Therefore, initial planning of a high school vocational-technical program begins by defining the career or vocational clusters and majors to be offered. Schools can base their career majors on students' career interests and career opportunities available in the community, region and nation. Different schools often make different selections.

Schools can expand students' access to quality vocational majors by developing cooperative arrangements with postsecondary technical and community colleges, regional area vocational-technical centers or neighboring high schools. They can also arrange for learning activities at the work site. The intent is to plan centers of excellence for career and vocational majors. Most high schools find it impossible to provide quality in-depth vocational programs in a full range of majors. Thus, it is imperative for high schools and communities to share school and work site resources.

When schools try to do too much by offering programs for which they lack adequate resources, they become "holding tanks" for students. A community does not need—nor can it afford—to have multiple programs in highly technical fields (such as automotive technology) that require costly equipment and other resources. One high-quality program is preferable to a number of low-quality ones. No high school is expected to provide access to all career clusters or all majors within a cluster. (See page 22 for one way to think about possible career clusters and related majors.)

One Approach for Organizing High School Vocational Studies into Career Clusters and Majors

Career Clusters	Career Majors	
Business, Marketing and Management Occupations	Management Finance Administrative Support	Marketing Computer Network Systems
Engineering and Science-Related Occupations	Electomagnetic Technology Mechanical Technology Chemical Technology	Earth and Atmospheric Technology
Health Occupations	Health Diagnostics Health Therapy	Health Support
Community and Consumer Service Occupations	Legal Services Counseling Services Public Safety Regional Development Grooming Services	Family Services Hospitality/Travel Cleaning Services Food Technologies
Arts, Media and Communications Occupations	Creative Arts Applied Arts Liberal Arts	Education Information Services Publishing Services
Agriculture, Forestry and Natural Resources Occupations	Agriculture and Conservation	
Construction Occupations	Construction Trades	
Service Technician Occupations	Light Mechanical Service Heavy Mechanical Service	Transportation Service and Repair
Manufacturing and Production-Related Occupations	Industrial Design, Research and Development Manufacturing and Production Operations	Industrial Maintenance Industrial Support Transportation Operations

Source: This approach is taken from *Integrated System for Workforce Curricula* and is used with permission from the Center for Occupational Research and Development in Waco, Texas.

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An academic major can be one of the options offered to students who know they want to pursue higher education but do not have a specific career focus. Academic majors include liberal arts, humanities, a second foreign language, mathematics and science. The major represents a concentration of courses that students take above the traditional college preparatory program of study. Students preparing for college often have a career goal that provides a focus for their high school education.

For students who want to pursue an academic major, one attractive option is the International Baccalaureate. This rigorous pre-university course of study culminates in examinations to determine eligibility for an IB degree. This option is designed for high school students who want to enroll in challenging university and professional studies. The comprehensive curriculum offered in the last two years of high school allows students to fulfill the requirements of various national systems of education. IB graduates often receive advanced standing and college credit. (See page 24 for International Baccalaureate requirements.)

Many students completing a college preparatory program of study will have clear goals in mind. For them, the career majors listed on page 22 can provide a focus for their high school education and can help them confirm the fields they want to pursue in higher education. Career majors do more than prepare students for entry-level jobs; they introduce them to a whole range of careers within a broad area, whether the careers are craft, technical or professional.

Many career-bound students plan to attend college after high school. A career major gives them direction and helps them confirm their interest in a career field. Research has shown that young people who develop a focus during high school are more likely to be prepared to enter college and earn a degree.

The standard for vocational education in the past was preparation for an entry-level job in a narrowly-defined occupational field. This is no longer the case. Today, career majors are the central organizing focus for high school vocational studies. All vocational fields of study have a career ladder that includes a range of jobs from entry-level through professional and supervisory positions. To prepare for these careers, students generally need education beyond high school or some form of on-the-job training. They often need to continue their education through the baccalaureate level. New vocational programs introduce students to the academic, technical, thinking and personal competencies required to perform at all levels. Modern programs also dispel the stereotype of vocational education as nothing more than preparation for entry-level jobs.

International Baccalaureate Requirements

Candidates for an International Baccalaureate diploma are required to study languages, sciences, mathematics and humanities in the final two years of high school. The intent is for students to learn how to learn, how to analyze, how to reach considered conclusions about people—their languages, literature and ways in society—and the scientific forces of the environment. The IB curriculum has been shaped over the years by educators committed to international education. The subjects that comprise the core of the IB curriculum are arranged in six groups (see below). Students seeking an IB diploma are required to select one subject from each area. Three of these subjects are studied at a higher level and three at a subsidiary level (or a maximum of four at a higher level and two at a subsidiary level). By arranging the work in this fashion, students are able to study some subjects in depth (higher level), i.e. extensively over a two-year period, before sitting for examinations, and to study some subjects in breadth (subsidiary level), exploring a range of topics within a subject.

IB Subject Groups

Language A	**Language B**
Literature	Modern Foreign Language

Individuals and Societies
Includes History, Geography, Economics, Philosophy, Psychology, Social Anthropology and Organization and Management Studies

Experimental Sciences
Includes Chemistry, Biology, Physics, Environmental Systems and Design Technology

Mathematics

Sixth Subject
Includes Art/Design, Music, Computing Studies, Classical Languages, History and Culture of the Islamic World; a second subject from the social studies or sciences group; another modern language; or a school-based syllabus approved by the IB organization.

Other Requirements

Theory of Knowledge
A unique course designed to stimulate critical reflection upon the knowledge and experiences gained both inside and outside the classroom, to evaluate the bases of knowledge and experience, and to develop a personal mode of thought based on critical examination of evidence and argument.

Extended Essay
An original and independent piece of research and writing on any subject within the IB curriculum.

Creativity, Action, Service (CAS) Program
A planned and supervised program of extracurricular activities related to the local community.

For more information about the International Baccalaureate, contact:

International Baccalaureate North America
200 Madison Avenue, Suite 2007
New York, NY 10016-3903
Phone: 212/696-4464 • Fax: 212/889-9242

As a career or vocational major is being planned, educators will want to think of the entire 24-28 credits students will earn in high school and begin to lay out a coherent academic sequence. The sequence should support career majors that prepare students for employment and further education, whether in an apprenticeship, a technical school, a community college or a university. The total array of academic and vocational courses becomes a student's program of study.

Identify the Courses for Each Major

In most instances, the building blocks of courses for a career or vocational major will come from the vocational curriculum. However, there are exceptions. A course may blend a traditional academic course and a specialized vocational course and be taught by an academic teacher. For example, an international business major might include a business course taught in a foreign language. An economics course for a financial studies major might be taught by a social studies teacher, while a course in quality control for a major in manufacturing science might be taught by a mathematics teacher.

Some courses fulfill the requirements for multiple majors. For example, a course in food science may be part of a hospitality industry, health occupations or early childhood education major. A course in computer-assisted drafting and design or basic electronics may be part of several majors.

The courses within a career major should provide students with the competencies and experiences needed to enter a broad range of careers within that field or to pursue postsecondary education. *High Schools That Work* recommends that a career major consist of a minimum of four vocational courses, two related courses and an upgraded academic core. (See pages 26-27 for examples of courses that might be included in a range of career majors.)

Programs of Study* for Career Majors

High Schools That Work-Recommended Upgraded Academic Core

Course	**Credits**
College preparatory English	4
Mathematics (College preparatory courses such as Algebra I and II, Geometry or Calculus should represent at least two of the credits.)	3
Science (College preparatory courses such as Biology, Chemistry or Physics should represent at least two of the credits.)	3
Social Studies (College-preparatory courses such as Economics, Government, Geography or State, American and World History should represent at least two of the credits.)	3

Recommended Courses for Career Major — Finance

Complete four credits from the following major courses:

Economics	1
College-Level Accounting	2
Banking and Credit	1
College-Level Principles of Finance	1
Business Internship	1

Complete two credits from the following support courses related to the major:

Computer Applications	1
Foreign Language	2
Word Processing	1
Small Business/Entrepreneurship	1

Recommended Courses for Career Major — Manufacturing

Complete four credits from the following major courses:

Statistics	1/2
Manufacturing Processes	2
Electronics	1
Drafting and Design	1
Internship in Manufacturing	1

Complete two credits from the following support courses related to the major:

Economics	1
Word Processing/Computer Applications	1
Introduction to Technology	1
Foreign Language	2

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Programs of Study - *cont'd*

Recommended Courses for Career Major — Health Occupations

Course	**Credits**
Complete four credits from the following major courses:	
Health Careers Exploration	1
Anatomy/Physiology	1
Health Occupations Lab	2
Internship in a Health-Related Setting	2
Complete two credits from the following support courses related to the major:	
Word Processing/Computer Applications	1
Food Science	1
Early Childhood Development	1
Foreign Language	2

Recommended Courses for Career Major — Travel and Tourism

Complete four credits from the following major courses:	
Travel and Tourism	2
Geography	1
Economics	1
Internship in a Related Business	1
Complete two credits from the following support courses related to the major:	
Word Processing/Computer Applications	1
International Economics and Finance	1
Foreign Language	2

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* The programs of study shown here are based on typical requirements at high schools offering career majors. All examples meet the *High Schools That Work* recommendations for an upgraded academic core, four vocational courses and two related courses.

Chapter 4

Designing a Course: An Overview of the Issues

The remaining chapters of this book will contain ideas for developing vocational courses that achieve the *HSTW* vision. This chapter addresses the overarching issues. Chapter 5 will help teachers get started in planning and setting goals for their courses. Chapter 6 will address projects—the core content of courses—and instructional strategies for helping students meet challenging requirements. Chapter 7 will focus on student assessment.

Content Is Determined by the Expectations of a Career Area

The content of vocational courses is driven by what students need to know, understand and be able to do before entering and advancing in a career area. Each career major consists of academic, technical, intellectual and personal knowledge to be gained by all students in the major. This core knowledge base is common and important to the range of careers within the major. Delivering the core knowledge base will require teachers to:

- Identify the range of occupations to be addressed in the major;
- Identify the knowledge and skills that apply to occupations in the major;
- Teach the knowledge and skills related to several occupational contexts.

As the instructor introduces students to major course goals, he or she can provide a clear rationale for why students need to learn the content and what they need to do to meet course standards.

For example, if the career major is business and the instructor is developing a microcomputer course, he or she can identify knowledge and competencies that can be generalized to a range of business-related jobs. This might include knowledge and skills needed by accountants, business managers and administrative assistants versus the knowledge and skills associated with only one occupation. After developing a list of knowledge and competencies, the teacher can share it with other vocational and academic instructors as the basis for developing an integrated curriculum.

High Standards Encourage Students

Good vocational teachers know their students and hold them to high standards. They work with them to define what is meant by quality learning and base the standards on what students must learn to master the concepts in the curriculum. Connections between academic and vocational courses are made exceptionally clear. When academic competencies such as writing, mathematical applications or scientific processes are required, students are held to the same standards they would be expected to meet in any academic area. Higher standards may mean that many students will need instruction that reveals the purpose of concepts, sequences of steps, methods of application or expectations of results.

Innovative teaching and learning strategies will encourage students to persevere to achieve the course standards. Rubrics will help students know what is expected of them. Good assessment will motivate students to satisfy course requirements and will increase personal awareness of quality work. Students will respond positively if they understand that the course standards are the standards that will be upheld in the workplace. By focusing on workplace expectations, students will learn that employers expect strong communication and mathematics skills and the ability and inclination to take the initiative.

Projects Provide a Focus for Learning

Vocational educators can design courses that teach a mixture of technical, intellectual, academic and personal skills by exposing students to a range of problems and issues typical of those found in a career field. This will help students see how what they are learning fits together to produce real work.

Teachers can also plan instructional activities that give students practical experiences with tools, equipment, materials and problems associated with chosen careers. Projects can become the focus for teaching essential knowledge, understandings and skills. As students complete each major project, teachers can integrate the process so that students will understand how related technical and academic knowledge and skills are interrelated with specific work responsibilities.

At the beginning of the course, the teacher will predetermine the majority of the projects so that students will learn and apply the essential core academic and technical competencies. As students gain knowledge and skills, they can play a larger role in selecting and planning appropriate career-related projects. The instructor will always be involved in the process, but he or she will participate as a collaborator rather than as the sole determiner of a project. Students learn self-reliance, independence and interdependence by setting the direction of their learning, monitoring their progress and evaluating the results.

The Teacher as the Manager of Instruction

Vocational teachers can create learning activities as part of the total instructional plan without being the sole source of knowledge. They can begin with what students already know about the concepts and skills being taught. By uncovering previous knowledge, teachers can effectively and efficiently create a bridge to new information. In addition, vocational educators can collaborate with instructors from other subject areas as part of a teaching team. Through the efforts of an interdisciplinary team, students can benefit from instructional strategies such as cooperative learning, reciprocal teaching and paired problem solving. Students can also learn techniques for gathering information from external resources.

Students—individually and in teams—will have multiple opportunities to work on projects, produce products and address modern workplace issues. Students who are involved in the learning process from the beginning will have more opportunities to learn basic concepts, safety procedures and problem solving strategies. They can search technical resources and talk with experienced workers on the job as they develop procedures for solving problems. They can also document the procedures by comparing them to established technical processes.

The Community as a Learning Lab

Students can be given opportunities to use business, industry and other community resources to supplement the instruction they receive at school and to explore their personal interests. The use of multiple resources from the community can expand students' understanding of a career field. Independent study, team projects and participation in internships and other work-based learning opportunities are vital components of quality instruction.

Continuous Assessment

Continuous assessment is necessary to gauge students' progress in understanding concepts and skills within a career major. The assessment should be based on the academic, occupational and employability knowledge and skills needed for a career major. Teachers can use strategies such as rubrics, checklists, self-reflective questionnaires, paper-and-pencil tests, demonstrations and work site evaluations to guide students in assessing their own work. Portfolios enable students to display works-in-progress as well as those completed. As a result, students become actively involved in monitoring and evaluating their own learning. This in turn can result in the type of independent, responsible behavior valued so highly in the workplace.

The major purpose of assessment is to give students and the instructor a clear understanding of progress toward achieving course standards. Students need to know they will be given multiple opportunities to learn the content. However, they must make a solid effort the first time and must complete subsequent attempts on their own time.

Another purpose of assessment is to assign course grades reflecting the extent to which students have met course standards. Students need to realize that they cannot turn in inferior work and expect to get a passing grade.

Vocational-technical instruction needs a new definition of "quality." Modern vocational programs must offer challenging programs of study that prepare students for a broad career field and further education rather than for a narrow entry-level job. (See page 32 for a summary of old and new instructional practices.)

The Instructional Design Process

Given the new goals for vocational-technical courses, the instructional design model is based on determining:

- What knowledge, understandings and skills are needed to enter and continue to learn in a career field;
- What knowledge, understandings and skills are needed for education beyond high school;
- How vocational-technical skills can be integrated with academic skills.

Performance-based instructional design is a process that states in broad terms what students are expected to know, understand and do to enter and continue to advance in a career.

- "Knowing" includes any information needed to carry out a given process with understanding and meaning. The knowledge base will include ideas, concepts, theories, inquiry methods and thinking habits necessary to complete the processes being taught.
- "Understanding" carries learning to a new dimension. It involves the ability to connect skills, to address a topic and to do a variety of things such as explaining, finding evidence and examples, generalizing, applying, analyzing and presenting the topic in a new way. When understanding exists, students know how to perform an activity, when to do it and why they are doing it. They can explain the process and know when they have done it right.
- "Doing" encompasses a broad range of processes, including processing information intellectually, using one's hands to complete a task, and behaving in ways considered appropriate for a professional in the field being studied. "Doing" could include solving mathematical problems, loading new software

Instructional Practices

The Old Way	The New Way
Instruction focuses on procedural skills.	In addition to learning procedural skills, students are given open-ended problems requiring the use of technical, academic, cognitive and personal skills.
The vocational teacher handles the majority of the instruction.	Vocational and academic instructors work together.
Students follow a set of steps to complete assignments.	Students are given open-ended assignments that require them to do research and to prepare their own steps for completing them.
The instruction takes place in the classroom and laboratory.	Classrooms, laboratories, business and industry, the home and the community are all locations for instruction.
The content is determined by what the instructor likes to teach or the students want to learn.	All students must learn a core set of major competencies.
Standards vary according to each student's perceived ability.	All students are expected to meet the same high standards.
Assignments do not require students to use academic and thinking skills.	The teacher uses activities and problems that require students to integrate and use multiple academic and technical competencies.
The teacher assesses student learning through informal observations or performance and written tests.	Assessment is continuous, using a wide variety of techniques that focus on standards.
All assessment is done by the teacher.	Students evaluate their own work based on the definition of quality learning that they have developed with the teacher before submitting it for the teacher's review.
Assessments are conducted primarily for assigning grades.	The purpose of assessment is to help students and instructors improve, as well as to determine grades based on standards.
Students get one chance to learn the content before they are graded.	Students are given multiple opportunities to learn the content. They may be expected to use their own time to meet quality standards.
Students are not expected to work outside of class.	Students are expected to work on assigned projects outside of class.

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into a computer, making a decision about the social impact of technology on society, determining how to treat hospital patients to increase their comfort, or deciding which equipment to use to carry out a procedure.

The goal for vocational teachers is to help students acquire the ability to "know," "understand" and "do." "Teaching for understanding" is the focus of many of the course development strategies suggested in Chapter 6.

Instructors who focus on knowing, understanding and doing expect students to learn essential academic and technical concepts and apply the content correctly. In teaching for understanding, it is not enough for an instructor to simply teach students how to load new software into a computer. Rather, the instructor can design an activity that enables students to learn related concepts and knowledge. Students should be able to demonstrate the correct technique and deliver a written or oral report of what they learned. They should be able to calculate on the basis of certain criteria, articulate an implementation plan and provide supporting evidence for decisions made in the process. Authentic assessment strategies can be used to measure students' proficiency.

The teacher's role is to introduce career competencies and to help students learn how to perform them safely and correctly. As students acquire knowledge and skills, they can collaborate with the teacher to organize learning experiences. Students can conduct research, learn from each other and refer to technical manuals and related materials in carrying out projects. In doing so, they can learn how to apply specific processes in the context of real work.

The instructional design process asks teachers to determine what they want students to know and to do. The process also calls for identifying the associated academic, intellectual and personal skills that students will need.

Your Course Syllabus

As you follow the steps in the performance-based instructional design process, you can record your decisions in the outline in Appendix A. The outline includes sections for your course goals, instructional strategies and assessment plans. As you read about various aspects of the instructional design process, you will be asked to complete the corresponding section of the syllabus.

The sample syllabus in Appendix B will help you complete a syllabus that meets the *HSTW* vision of a vocational course. The sample is mentioned a number of times in the description of the course design process. The basic design process includes seven steps. The steps and the chapters in which they are discussed include:

Chapter 5

Step 1: Describe the course.

Step 2: Clarify the instructional philosophy.

Step 3: Determine major course goals.

Chapter 6

Step 4: Select and put into sequence major course projects.

Step 5: Develop project outlines.

Step 6: Decide on an instructional delivery plan.

Chapter 7

Step 7: Develop an assessment plan.

Chapter 5

Designing a Course: Planning and Setting Goals

This chapter contains ideas for setting course goals and describing the course and the instructional philosophy.

Step 1. Describe the course.

Modern high school vocational-technical courses are intended to help students prepare for a broad career area or a specialized occupational field and acquire the knowledge, understandings and skills needed to continue to learn and advance in the career field. These courses must help students see career ladders and must not foreclose on future options.

The first activity in course design is to develop a clear three- or four-sentence course description—the kind of brief overview that might appear in a course catalog. The description should include five vital pieces of information:

- Aim of the course: A one-sentence description of the purpose of the course.
- Place within the program of study: Where the course fits within a career or occupational major and/or in relationship to continued study in a broad field.
- Topics covered and expectations for student involvement: Specific topics or units of instruction and the types of student participation expected—for example, work site learning, internship, collaborative project-based assignments, etc.
- Length of the course: Whether it lasts a semester or a full-year; whether it is a one-, two- or three-hour course.
- Prerequisites: Courses students must complete before taking this course, if applicable.

The following example will help vocational teachers develop appropriate course descriptions:

Example: Introduction to Word Processing

Aim: Students will learn at least one word processing system and how to apply it to a variety of tasks performed in modern offices.

Place within the program of study: This is a required course for students planning to pursue business, office technology or marketing majors and is a prerequisite for other word processing courses. It is also recommended for students who want to learn word processing and be able to use it to perform tasks for study or career roles.

Topics Covered: Keyboarding; processing information from the Internet; gathering documentation for reports; formatting tables, graphs and charts; and writing business documents such as letters, memoranda and reports. Students are expected to work in teams to produce a document for use in the community.

Length: A one-year, one-hour course.

The course description should specify the content, expectations, time frame and context of the course within a larger curriculum structure. Otherwise, the teacher and the students would enter the learning process without direction. It is impossible to develop a course if the aim is not clear.

Enter your course description in Section 1 (Course Description)
of the Course Syllabus in Appendix A.

Step 2. Clarify the instructional philosophy.

The instructional philosophy states the instructor's views about the purpose of instruction. It guides decisions about what will be taught, how it will be taught and what the course standards will be. The philosophy has a number of dimensions:

- **Instructors' expectations for student performance are important.** Teachers don't want to stop with simply teaching students to use technology; they want students to understand its function and be able to apply it to complex projects. In the new vision for vocational studies, all students are expected to meet the same high course standards. This new philosophy rejects the "accommodation" mind-set that allows some students to coast through a course without mastering the competencies. Customers don't want someone who was a "C" student in high school to work on their car or take care of their medical records. The public expects employees to be able to analyze situations, determine what is needed and take responsibility for doing things correctly. This will not happen if students are not held to high standards in their course work.

- Since students have varying levels of ability, this new philosophy asks teachers to **design instruction that builds on students' strengths** in terms of learning styles, interests and areas of expertise. If students believe the information and experiences they bring to the learning event are recognized by the teacher, they are more likely to be actively engaged and successful. Some students will need additional direction and practice as knowledge and skills are acquired. Teachers who incorporate peer interaction as a viable means of learning new concepts and practicing new skills establish a learning environment that more closely resembles the real world of work. Further instruction through summer school and tutoring should also be included.
- **How instruction will be delivered** should be clearly stated for students and teachers at the beginning of and throughout the course. As students collaborate in the learning process, their participation increases. Teachers can use a variety of strategies to help students gain knowledge and skills in procedural techniques, open-ended problem solving, creative solution seeking, integrated academic and technical concepts, high-level thinking and problem solving. As different approaches to teaching and learning are implemented, a balance of approaches should be sought. Information delivered through a lecture or recitation mode should be brief and visual. The lecture should provide plenty of opportunities for student discussion and questions to clarify concepts. For the most part, instructional strategies should actively engage students in hands-on experience with the use of knowledge and skills and should make a solid connection to real-world application of the concepts.
- The philosophy statement should emphasize that students are expected to work **independently and in teams** to carry out difficult projects that constitute a major portion of the course content. Students will be expected to conduct research and try a variety of strategies to solve problems and complete assignments. This will help students become the type of independent learners and analytical thinkers that are needed to address situations in the workplace. Students will also need to draw on academic skills to carry out course requirements. The philosophy statement should establish that students will not just learn procedures without knowing why they are being asked to do something and when they will do it. They will be expected to understand the complete process of solving a problem or carrying out a project—and the reasons for taking each step.
- Teachers can **use the community** as an extended learning lab. The philosophy statement can talk about internships, job-shadowing experiences and community research that may be part of the course.

- **How students will be evaluated** is part of the instructional philosophy. The philosophy statement should explain that feedback will be provided throughout the course so that students can make corrections if their work is not up to par. It should also state that the teacher will help students develop the ability to judge their own work. The statement should point out that students will be held to safety and quality standards expected on the job. It should also explain the value the teacher places on portfolios and written and oral presentations—not just tests of facts and knowledge—to assess student performance. Students will not just be evaluated on outcomes but on the thinking processes they follow and the alternatives they consider in arriving at solutions to problems and in developing projects they will complete during the course.

In summary, the instructional philosophy should explain expectations for student performance, how instruction will be delivered, the use of community resources and how students will be evaluated. This philosophy statement is a critical part of the course syllabus, because it explains how this course differs in expectations and delivery methods from what students and parents may have come to expect in the past.

Use Section 2 (Instructional Philosophy) of the Course Syllabus in Appendix A
to enter a brief statement regarding the instructional philosophy
to be used in the course you are developing
You may want to refer to the statement shown in the Sample Syllabus in Appendix B.

Step 3: Determine major course goals.

Setting the right goals is a critical factor in developing a course in keeping with the *High Schools That Work* vision. In the past, vocational courses often focused on teaching sub-skills (or tasks) associated with an occupation without any concern for how the sub-skills could be applied to larger "real work" activities. Typical job-analysis procedures offer long lists of sub-skills. Although the identification of these sub-skills is an important source of information about occupational skill requirements, they do not provide sufficient definition of the instructional content and goals for vocational courses of the future.

Course goals must reflect the critical knowledge and skills that students need to understand and use about the subject matter to help them in further education and continued learning in a career field. These competencies include technical, academic and higher level intellectual as well as employability skills and should be based on competencies that can be generalized to occupations included in the career major program. These competencies can be addressed with the aid of an advisory committee comprised of instructional staff and representatives from business and industry. Other sources of information are the standards developed for all academic disciplines and the national skill standards developed for 22 career fields under the auspices of the National Skill Standards Board. These standards, which were developed by teams made up primarily of employers, offer critical guidelines for educators to follow in setting course goals. If standards are available through this documentation for a field covered in a course, they can be a valuable source of information about appropriate course goals. (See Appendix C.)

Helping students acquire critical thinking and personal skills is another important consideration in setting course goals. These skills were identified in the 1991 report of the Secretary's Commission on Achieving Necessary Skills (SCANS), established by the U.S. Department of Labor to look at the skills American workers need to be competitive in a world economy. For more information about the SCANS skills, you may want to refer to the SCANS report, *What Work Requires of Schools*, published in 1991. The document is out of print, but single duplicated copies are available at no charge upon request from the Employment and Training Administration, U.S. Department of Labor, 200 Constitution Ave., NW, Room 54206, Washington, DC 20210. Phone 202/219-6871.

More than 10,000 educational standards have been developed. Finding the standards related to a particular course can be mind-boggling. The Center for Occupational Research and Development (CORD) in Waco, Texas, has developed Integrated Curriculum Standards (ICS) merging relevant academic, occupational and employability standards. These standards can be invaluable to educators in the curriculum development process. (See page 40.)

The course goals should be clearly-worded, integrated statements that provide a vivid image of what students are expected to know, understand and be able to do after completing the course. The statements should describe an array of outcomes, including designing and making a product, making a decision, considering and evaluating alternatives, finding solutions to unfamiliar problems, repairing equipment and handling difficult situations.

Course goals should emphasize big ideas and major career performance competencies that are important for the course, ranging from basic knowledge and application of knowledge to familiar and unfamiliar situations, developing and carrying out a plan and making judgements. If the scope of the course is one occupation, the goals will represent major responsibilities within that occupational area. If the course is designed for a career cluster, the goals will apply to major competencies reflective of multiple careers in the cluster.

Integrated Curriculum Standards

Development of Integrated Curriculum Standards (ICS) is a major component of the Integrated System for Workforce Education Curricula (ISWEC) project. The project is a collaborative effort of a consortium of states and the Center for Occupational Research and Development (CORD) in Waco, Texas. The project will result in a system that state and local educational systems can use to effectively integrate curricula and teaching methods that address the changing workplace.

The ISWEC project started with the development of a recommended career-cluster model with career majors identified within the clusters. (See page 22.) Using the model, a detailed curriculum development process is being followed to integrate academic, occupational and employability standards to form ICS. Standards for three career cluster areas (Business, Marketing and Management Occupations; Engineering and Science-Related Occupations, and Manufacturing and Production-Related Occupations) are currently available.

For more information on the ICS data base and related materials, contact CORD toll-free at 1-800-972-2766 or write ISWEC, Center for Occupational Research and Development, P.O. Box 21689, Waco, Texas 76702-1689.

Writing Goal Statements

Capture the course goals in 6 to 10 statements about what students are expected to learn. All goals should represent large units of real work rather than narrow sub-skills or tasks. These sub-skills should be taught in the context of major units of work and major projects, not as isolated skills. Goal statements help students understand why they are learning the skills, how the skills relate to real work activities and how to apply the skills meaningfully and competently. Goals should stress that students will learn thinking, planning and problem-solving skills as part of the course. All course goals must be clearly defensible in terms of their value in providing students with competencies and knowledge needed in the workplace.

The following guidelines will help teachers develop goal statements:

- **Determine where the course fits** into the overall high school program of study. Is the course introductory or advanced (based on previously-acquired knowledge and skills)? Your course should include a unique body of knowledge, understandings, and intellectual and operational skills not taught in other high school courses.

- **Consult with educators outside the school.** They may include postsecondary educators who provide subsequent courses in the field and apprenticeship or internship coordinators who manage work-based learning programs related to your course. These connections enable instructors to avoid duplication and to determine when it is appropriate to teach certain content.
- **Consult with employers** to ensure that course goals represent authentic workplace activities and skills that employees are expected to possess to enter and advance in the field.

Essential Competencies

All course goals should help students acquire four types of competencies:

- **Technical** — Major concepts or processes that students need to achieve course goals. They include what people do with their hands, the decisions they make and how they treat other people, data or things.
- **Academic** — Topics, concepts and procedures from all academic fields that students will have to learn and apply to successfully attain course goals. The academic fields include:
  - Language arts (reading, writing, listening and speaking)
  - Mathematics
  - Science
  - Social studies
- **Thinking** — Competencies required when students are given open-ended assignments asking them to create new designs, find new solutions, develop procedures for addressing a problem or project on their own and explain their reasoning. Employers consider "thinking" skills essential for success in the workplace. The cognitive skills include:
  - Creative thinking
  - Decision making
  - Problem solving
  - Knowing how to learn
  - Reasoning
- **Personal** — The qualities of a successful worker, including:
  - Taking responsibility for their own learning
  - Working with and learning from others
  - Displaying self-management, including the ability to complete assignments on schedule
  - Possessing integrity

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Questions for Judging Major Course Goals

A good set of course goals will address each of the following questions. Some goals may address more than one question.

1. What specific bits of technical and academic information is the student expected to recall, recognize or have knowledge of as a result of this course (symbols, terminology, facts, trends and directions, classifications or categories, criteria for making judgements, common procedures employed and organizing principles)?
2. What translations, interpretations, estimations or predictions are students expected to make when confronted with written and oral communications or physical demonstrations representative of the technical content covered by the course?
3. What problem(s) or projects will the student be expected to solve or complete by becoming familiar with the problem or project, remembering and bringing to bear the appropriate technical and academic procedures and principles and applying correctly the appropriate methods to the solution of the problem or completion of the project?
4. What analyses are students expected to make by breaking down—data, a production process, a particular technology or material, a product or service, interaction of members of a study or work site team and written or oral assignments—into smaller parts, and detecting the relationship of the parts and the way they are organized to convey meaning, to draw conclusions or to redesign a product?
5. How are students expected to synthesize what they have learned into a new and meaningful framework or product by production of a unique communication (paper, video, speech, etc), produce and carry out a plan or proposed set of operations or study the facts of a given situation and classify or organize them into a logical, consistent scheme?
6. What judgements—accuracy, economy, effectiveness, satisfaction, etc.—are students expected to make about the value of a given technology, product, material, procedure, idea, etc. to complete either a school or work site assignment?

- **Use an advisory committee** to assist in goal selection. Each career major should have an advisory committee comprised of representatives from businesses and industries in the occupations represented by the career major; programs in the occupational field or career cluster at two-year community or technical colleges and institutions of higher education; language arts, mathematics, science and social studies programs at your school; and the high school guidance department. Advisory committee members can assist in many ways that will be discussed throughout this book.

Sample Course Goal Statements

The following statements are examples of solid goal statements. They do not represent a comprehensive list of goals for any of the courses shown. The number in parenthesis represents the goal levels as evaluated by the six questions for judging major course goals on page 42.

Course: Drafting

- Read and design blueprints. (2) (5)
- Create three-dimensional drawings using computer-assisted design; use this skill to design and complete a metal fabrication project. (3) (5)

Course: Mechanical Engineering

- Research, communicate and justify design ideas throughout the design and production process for student-designed projects. (5) (6)
- Develop a plan (including a time line) for producing products. (5)
- Produce products by using safe and appropriate metalworking and woodworking skills. (3)
- Develop criteria and apply them to evaluation of products. (6)

Course: Desktop Publishing

- Evaluate and select alternative layouts based on economic considerations. (6)
- Develop a variety of layout designs for use in the workplace. (2)
- Format newsletters and business reports by using a variety of word processing and graphics software programs to produce documents for a business in the community. (2) (3)
- Develop criteria and apply them to the evaluation of each type of layout. (6)

Course: Banking and Finance

- Recall information about major functions of banks and other depository systems, the Federal Reserve System and modern trends in banking. (1)
- Recognize basic accounting principles consistent with standards in the banking industry. (1)
- Investigate the credit records of individuals and determine their worthiness. (4)
- Plan and operate a student bank and analyze the value of students operating a school bank. (4) (5)

Course: Introduction to Health Occupations

- Select one occupation from the health field to explore in depth; determine the educational and personal effort required to enter the field. (2)
- Identify common infectious diseases, including causes, appropriate treatments and prevention; assess your own habits and those of others in preventing the spread of disease. (2) (4)
- Become familiar with guidelines for patient care, observe their application in a job-shadowing experience and maintain a journal of your observations. (2)

For more examples of goals, see the Sample Course Syllabus in Appendix B.

- **Develop major performance goals** that fit within the course parameters and represent essential concepts that students are expected to know and do after completing the course. These goals should evolve from discussions with the groups represented on your advisory committee. They should reflect a blend of technical, academic, thinking and personal competencies that will prepare students to enroll in postsecondary studies and/or enter and advance in the career field addressed by the course. (See page 41 for the four types of competencies that all course goals should include.)
- **Test each goal** to make sure it is something that students can recognize, explain, apply, analyze, create and evaluate. (See page 42 for six questions for judging the adequacy of course goals and page 43 for examples of course goal statements that meet one or more of the six questions.) A good set of goals for a course will either directly or indirectly imply a focus on specific information students must know and comprehend.

Reviewing Course Goals

A clear relationship exists in the identification of major course goals, the identification of specific competencies to be taught to meet the goals and the learning activities that will be used to teach them. Major course goals are both the basis for identifying specific competencies and the vehicle for selecting the array of projects around which skills related to real-world activities will be taught. Instructors are faced with the task of ensuring that the major course goals represent the desired range of knowledge, understandings and skills to be taught.

After goal statements have been written, make sure they are comprehensive and cover the critical content for your course. To conduct this review, consult your long list of sub-skills and appropriate standards documents to ensure that one or more of the goals you have developed will provide an opportunity to teach all of the sub-skills important to your course.

[illegible]

Chapter 6

Designing a Course: Projects and Instructional Strategies

After the course goals are determined, the next step is to decide how to meet the goals and teach the competencies. Specific competencies will be taught in the context of major projects or problems that constitute the major learning activities for the course. It is through projects that students acquire and apply the knowledge, understandings and skills that are critical in achieving the course goals. Projects provide a vehicle for integrating and teaching important content in the context of authentic career activities. This chapter describes how to select and sequence projects, make sure the projects encompass all the critical competencies and skills that students need to learn in the course and develop good project outlines. Instructional strategies for teaching a project-based course will also be covered.

Course Project Example

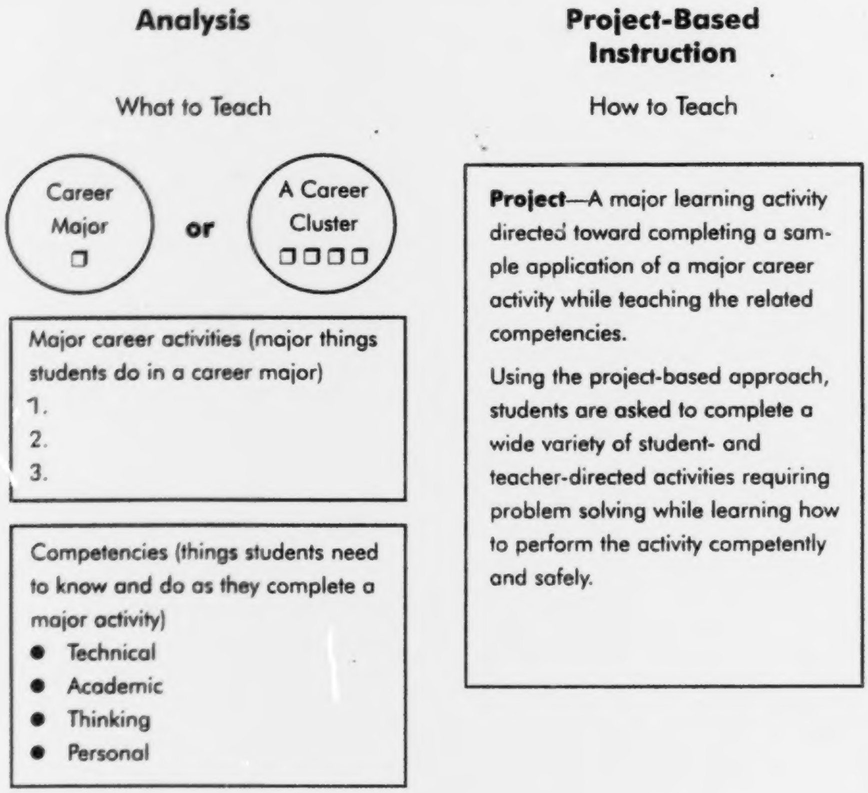
Drafting and Design—A Model Train Project

Drafting and design students at George Westinghouse Vocational Technical High School in New York City designed and built models of two magnetically levitated train cars and a section of track for a mass transit system.

Step 4. Select and sequence major course projects.

Projects or problems selected for the course represent sample applications of major activities that someone in a career field would complete on a regular basis. These projects or problems involve related learning activities that enable students to acquire the knowledge, understandings and skills needed to complete an assignment. Projects allow students to plan, collect and evaluate information, analyze situations and develop procedures for solving problems typically encountered in the workplace. They also provide a context for teaching technical and safety skills associated with the career major. It is important to select projects enabling students to learn career activities and competencies. When choosing projects to include in a course, always consider what they will be used to

Criteria for Selecting Course Projects



Analysis

What to Teach

Major career activities (major things students do in a career major)
1.
2.
3.

Competencies (things students need to know and do as they complete a major activity)
- Technical
- Academic
- Thinking
- Personal

Project-Based Instruction

How to Teach

Project—A major learning activity directed toward completing a sample application of a major career activity while teaching the related competencies.

Using the project-based approach, students are asked to complete a wide variety of student- and teacher-directed activities requiring problem solving while learning how to perform the activity competently and safely.

teach. (See the diagram above for the relationships between projects and the major career activities they represent and the competencies to be taught.)

A project may involve designing a product; making parts; assembling, testing and evaluating a product; developing and/or implementing a plan to meet a need in a local business; or operating a business in the school or community. Students might raise fish for sale, build a toolshed or make trailer hitches. Projects allow students to plan, collect and evaluate information, analyze situations and develop procedures to solve problems typically found on the job.

The problem-solving aspect of a project is crucial. Students need to learn that employees who solve problems and complete assigned projects are the ones who advance in careers. A good project will generally require a series of steps and the ability to make judgments and decisions when unexpected events occur.

Each project will not necessarily match only one goal; projects can help students advance toward several goals. On the other hand, students may sometimes need to complete several projects to meet a goal. A project can involve many activities that would not be undertaken in the real world. For example, students might be asked to observe someone doing an activity, discuss their observations with other students, find out from a mathematics or science teacher why something works the way it does and propose alternative ways of doing what is needed.

Projects add up to meaningful experiences that help students reach goals set for the course. Projects that cannot provide these opportunities have little value. (See page 46 for a diagram of how projects fit within course design.)

The scope of the course will help shape the nature of the projects chosen. A course designed to support the field of automotive repair will draw its major activities exclusively from that field. On the other hand, a course such as basic electronics may draw its activities from a range of career and work settings. (See page 48 for criteria for judging the adequacy of selected projects.)

The sample projects described throughout this chapter represent large units of real work rather than narrow sub-skills or tasks. Sub-skills are needed in completing major projects, but students should learn them as needed rather than as isolated skills.

Teaching Career Competencies

Although the emphasis in a course is placed on integrating projects, it is also important to make sure students learn to perform skills safely, competently and in a quality manner. Many competencies have safety implications: If someone fails to sterilize a thermometer, operate a saw efficiently or combine chemicals correctly, that person or others may be in danger. If someone errs in entering numbers on a balance sheet, cutting risers for a stairway or mixing ingredients for a cake, the quality of the finished project is adversely affected. Students should be expected to meet the standards of their career major. Therefore, quality vocational courses emphasize the necessity of meeting high performance standards.

Course Project Example

- **Manufacturing—An Analytical Chemistry Project**

A student from Forsyth Central High School in Cumming, Ga., serving a summer internship at CIBA Vision, a Novartis company, was assigned a project to compare two analytical chemistry techniques for determining the water content of soft contact lenses. One technique was complicated and time-consuming while the other could be performed in a few minutes. Working with a mentor, the student wrote a protocol for each technique, compared the results and prepared a report for supervisors. In conducting the procedure, the intern found that the simple and the complicated techniques were equivalent in determining the water content of the lenses.

Criteria for Selecting Course Projects

Good projects:

- Are large enough to cause students to acquire the major technical, academic and personal skills implied in the course goals;
- Require the completion of learning activities that result in work that would be done in a real workplace;
- Help students understand and experience the major technology used in the field;
- Challenge students intellectually;
- Allow students to address problems, projects and career activities they will encounter on the job;
- Require students to organize information, consider alternatives and use higher-order thinking skills;
- Present problems and open-ended situations;
- Require students to apply academic skills that are most needed to advance in the career field;
- Require students to learn from the teacher, other teachers and experts outside the school;
- Involve both individual effort and teamwork;
- Engage students in interacting and sharing ideas about ways to address a problem or situation and the lessons learned through the project;
- Allow students to present their projects to an audience of educators, students and representatives from the career field.
- Require students to work with authentic tools and materials representative of a career major;
- Have clearly-defined quality standards that students can use to evaluate their work and take corrective action.

Working with Others

Teachers have three important partners—employers, students and other teachers—to help them identify and plan course content and projects.

Employers — Employers are valuable allies in helping teachers identify content related to a career major as well as in helping find projects that enable students to apply career performance activities. Employers can also provide opportunities—such as job shadowing, mentoring and work experiences—to help students understand how things are done in the real world. Each career major should have an advisory committee comprised of employers from the field represented by the course.

Employers can also assist in finding community-based projects. For example, students could design a business office for a local company, present a layout to company personnel and receive a critique. In another example, students could present alternatives for developing a new community park and discuss the pros and cons of each alternative.

Students — Although it is important to learn critical content in sequential fashion, students need opportunities to make decisions about their projects, especially after learning some of the basic skills they are expected to master in the course. Students must be able to see the future value of their projects.

Discussions with students at *High Schools That Work* sites reveal that students are more highly motivated and do higher-quality work when they are involved in planning their own projects. This early involvement helps students learn how to think logically, solve problems and relate academic and technical skills. However, giving students a voice in project selection does not mean that "anything goes." Projects must meet high quality standards determined by the teacher and discussed with the student and must contribute significantly to one or more course goals. When students know in advance what is expected and why the projects are important to them, they will work harder and do better work.

It is important to establish guidelines for evaluating the projects and to advise the students of these guidelines at the beginning of the course. Students must understand that the teacher will not give them all the answers or tell them exactly what to do. Instead, students should research the sequence of steps and find the information for completing the project successfully.

Other Teachers — To complete challenging projects, students need to organize and use a range of knowledge and skills. Make projects so challenging that students will have to use knowledge and skills from language arts, mathematics, science and social studies; thinking and personal adeptness; and career expertise. Vocational teachers will want to plan and manage instruction so that students can acquire these abilities. Doing so will involve calling on academic teachers and other resource persons to help students develop knowledge, understandings and skills.

Course Project Example

Manufacturing—Computerized Construction of a Staircase

Student interns at Southern Staircase in Alpharetta, Ga., used computerized methods to design and manufacture a staircase that would meet customer expectations. The students developed the specifications for the stairway, including the width, the span to be joined by steps from bottom to top and the style of stairs needed (straight or circular). They used computer software to draw the plans and direct the appropriate machinery to cut the parts. Students assembled the parts, measured the finished staircase for accuracy and prepared it for delivery to the customer. Before delivery, the interns displayed their product at a celebration event for parents, employers, educators and fellow students. The event was the final activity in a summer internship in high-tech manufacturing conducted by *High Schools That Work* and Atlanta area schools.

Vocational teachers cannot work in isolation; they must assume a leadership role in reaching out to other teachers. When learning involves the workplace, a work site mentor can expose students to experiences that will help them achieve course goals. Work site experiences can also be coordinated to relate directly to the students' current career project. While project selection is taking place, vocational teachers can seek the ideas of other teachers. If other teachers and work site mentors know in advance the competencies students will need, they can emphasize them, thereby reinforcing what takes place in the vocational course.

Vocational teachers can build bridges to academic teachers by:

- Inviting them to observe students working on challenging projects in the classroom. Teachers from other disciplines can identify ways to use these projects and others to advance their goals for students in language arts, mathematics, science and social studies.
- Involving them in planning and taking part in major student projects so that they can define critical academic content related to each project.
- Asking them to serve on advisory committees so that they can hear from employers what students need that requires academic knowledge and skills.
- Arranging for academic teachers to visit work sites where vocational students are engaged in organized cooperative learning, apprenticeships, internships or job-shadowing programs.
- Encouraging them to develop and team-teach a unit with an employer.

Such experiences will enable academic teachers to investigate aspects of the workplace through the lens of a subject area and to discover workplace problems, projects and issues that can be used as authentic learning experiences to advance students' knowledge of a career discipline.

A Word of Caution

Vocational teachers need to be cautious as they involve employers, students and other teachers in identifying major projects. This involvement is valuable, but vocational teachers will want to keep some important considerations in mind. Projects should be based on criteria other than availability or what students want to do. They should also provide a range of experiences to expose students to essential content and competencies associated with the course.

Major projects can help students achieve course goals if teachers are clear about the knowledge, understandings and skills to be learned. Proposed projects can be evaluated by whether or not they give students opportunities to acquire knowledge or to make progress toward one or more goals.

Project Ideas

In talking with employers and other teachers, vocational instructors will think of many ideas for projects. To get the creative juices flowing, this chapter contains many examples of projects that other teachers have tried successfully. Four possible themes include:

◆ Job-Shadowing Projects

Virtually every vocational class can profit by taking students to work sites related to the course content. Through a series of job-shadowing activities, students can collect information about the knowledge, understandings and skills used in each job. Teachers can work with local employers to make job shadowing an experience in which students get to see the full range of a company's operation. Each experience lasts a half-day or more. Students may participate in more than one experience, but they should have the flexibility to choose the experiences that interest them most.

Teachers can devote class time to helping students get ready for these experiences. Explain to students that you expect them to interview employees to find out exactly what they do. Let students spend time in class deciding questions they will ask to learn the technical, academic, mental and personal skills required for the job. Assist students in developing a list of items to explore during the shadowing.

Encourage students to make a visual record of their experiences by taking photographs or videos. (Get advance clearance from company leaders. Many companies have policies that restrict photography, so be aware of what students can and cannot do.) To the extent that these activities are allowed, they can enrich individual portfolios and help students recall what they learned.

Course Project Example

Business—The Stock Market Game

Students at schools throughout the nation are learning investment skills by playing the stock market with the Stock Market Game. Teams of students use $100,000 in "play" money to buy and sell stocks on a weekly basis. They research, record, graph and track all transactions. Each skill is taught to industry standards by teachers in the business major. Sponsors provide trophies and other awards to winning teams. This project works well in business and finance classes. For more information on the Stock Market Game, contact the game's developers, the Securities Industry Foundation for Economic Education in New York City at (212) 608-1500.

Course Project Example

Manufacturing—A Machine Systems Project

Second-year students in the Manufacturing Engineering Technology Program in the Skill Center at Libbey High School in Toledo, Ohio, worked in autonomous, self-managed teams to build machine systems for local companies. After learning to perform basic skills during the first year, they were asked to apply the competencies to real problems during the second year. The instructor provided technical assistance and taught additional skills as needed.

◆ Internship Projects

Frequently, students participate in internships related to career majors. Internships usually last four to eight weeks during the summer between the 11th and 12th grades. A project can add a new dimension to the experience.

In internships, students are paired with work site mentors with whom they meet regularly. A student's project can result in a written report on an issue of importance to the company or a product that would be useful to the business. Students record their experiences in a portfolio which becomes part of the final grade. At the conclusion of the internship, students demonstrate their projects at a special event to which employers, school leaders and parents are invited. This type of exposure and recognition is vital in motivating and encouraging students to work hard.

High Schools That Work uses the project approach in a summer internship program designed to place students in high-tech manufacturing environments. Incorporating lessons learned from the program, *HSTW* prepared a guide titled *Planning and Conducting Student Summer Internship Experiences*. The guide contains step-by-step procedures, fact sheets and forms for use by students, parents, teachers, school coordinators and employers.

◆ Senior Projects

During their senior year, vocational students may be asked to prepare an exhibition. A senior project allows students to demonstrate the technical, academic, thinking and personal skills needed to complete a difficult problem or a research project in a chosen field of study. The project requires students to:

- Exhibit a range of technical competencies from a career major;
- Plan, design and complete work on schedule;
- Express understanding of academic and technical content both orally and in writing;
- Use research skills to decide how the project will be completed and to document the accuracy of the work;

- Use a wide range of outside resources;
- Distinguish the relevancy of an array of facts;
- Describe what they learned from the process.

Senior projects involve much work outside of class and require students to conduct interviews, perform research, synthesize information, reach conclusions, design and complete an activity, apply skills safely and effectively and meet the standards of the career major. In the process, students integrate knowledge from academic and technical studies. When the projects are completed, they offer a coherent way for students to demonstrate a full range of knowledge and expertise.

These projects are not for teachers' eyes only. They can be presented during an event to which employers, teachers, school administrators, students and parents are invited. An evaluation by a group of employers can become part of a student's final grade.

The *High Schools That Work* book titled *Teaching for Understanding through Integration of Academic and Technical Education* contains more information on senior projects.

◆ Across-the-Curriculum Integrated Learning Projects

Some of the most exciting projects being undertaken by schools in the *HSTW* network involve teachers from a number of subject areas. These projects require much teamwork and advance planning, but they are well worth the effort. Across-the-curriculum projects allow students to see how knowledge, understanding and skills are connected in completing activities in the workplace.

Projects provide numerous opportunities for teachers and students to link language arts, mathematics, science and social studies classes with vocational classes. To plan successful across-the-curriculum projects:

- Begin early. For complex projects, teachers may need to spend several staff development days during the summer to make plans.
- Be clear about the alignment of academic and technical content.

Course Project Example

Electronics—An Internship Project

Student interns at Siemens Energy and Automation in Alpharetta, Ga., worked in teams to build locking circuit boards. In doing so, they learned how to design and assemble electronic components to do a job. They had to diagram the board, fabricate parts, cut and attach wires and check for faults. They demonstrated their finished products at a celebration event for parents and employers. These students were participants in the Summer Internships in High-Tech Manufacturing Program sponsored by *High Schools That Work* and Atlanta area school systems.

- Schedule time for students from different classes to work together on the project.
- End the project with an event that allows students to demonstrate what they have learned and accomplished.

Prioritizing Projects and Activities

After you select the major projects and activities for your course, list them in the order of importance. It is not unusual for instructors to underestimate what they can cover in a course. If a teacher attempts to cover too much material, the course becomes an awareness course rather than one that helps students develop real knowledge, understandings and skills in a career major. Students benefit more if they are expected to learn a smaller amount of content well, rather than a large amount of material in an inferior way. Determine essential content and include it in the course goals.

Teachers are faced with a number of considerations in selecting projects and activities. Putting projects in priority order is really no different from determining what textbook content to teach first. Generally, a course has a logical progression of knowledge and skills. Projects that address the material that is ordinarily taught first are the projects that are assigned first. These projects are shorter, easier and less complex and focus on teaching basic technical competencies and applying academic procedures that underlie a career major. As students' knowledge grows, the projects become longer and more difficult.

Projects build on each other, allowing students to use skills, knowledge and understandings that they have developed through previous projects. The teacher's emphasis should be on teaching new things.

Creating Student Ownership of Projects

Since students will participate in an independent project as part of the course, they need to understand enough about the career field to determine if a proposed activity meets the project criteria. The teacher may want to select projects at the beginning of the course and allow students to choose their own pro-

Course Project Example

Marketing—Helping a Sagging Business

Teams of students in an advanced marketing course at McLean High School in McLean, Va., devised creative solutions to help a sagging bakery and catering business. Team recommendations were presented to the business owner, who gained some innovative strategies without hiring a high-priced marketing consultant.

jects as knowledge and understandings increase. However, every project should give students the opportunity to make some decisions about how the project will be conducted.

After students master basic competencies and associated safety procedures, they are allowed to become more independent, choosing the projects they will complete. Projects must challenge students and expand their knowledge, understandings and skills. Projects have the potential to increase student productivity and learning. They can also teach students how to think and advance academically.

As you prioritize and evaluate projects, you will find that some projects meet the test and others do not. Be willing to discard projects that do not hold up under this kind of scrutiny or that have a low priority in terms of overall importance.

[illegible] Section 4: Major Course Projects, of the Course Syllabus in Appendix A. [illegible] [illegible] and to examples in this book as you develop your projects.

Identifying Competencies and Content to be Learned in Each Project

Once you have identified the major goals for your course and have selected projects for achieving them, you will conduct a competency analysis of each project. This process is not recorded in the syllabus, but it is essential for completing Steps 5-7 (developing project outlines, deciding on an instructional delivery plan and developing an assessment plan). The competency analysis involves two actions:

- Determining the specific technical competencies that students need to learn to complete the project.
- Determining the supporting academic, thinking and interpersonal expertise that students will need to learn and apply to do quality work.

Although the process begins with the identification of technical and supporting competencies, all skills are interconnected and must be learned by the student prior to or at the time they are used to carry out an activity. This is an important consideration as the instructor lays out plans for the course.

Another approach would be to start with a list of competencies to be taught in the course and then select projects to address them. Projects are vehicles for teaching the desired competencies, whether the course begins with the projects or the skills.

Competency Checklist

Use this table to identify competencies that students will need to acquire to complete a project. The table allows you to break the project down into logical steps and list the skills needed for each activity. Skills should be taught as they are needed to complete a project.

Project Title: ____________________

Project Activity	**Technical**	**Academic**	**Thinking**	**Personal**
Activity 1				
Activity 2				
Activity 3				
Activity 4				
Activity 5				
Activity 6				
Activity 7				
Activity 8				

The competency checklist will help you identify what is needed to carry out course projects. It provides spaces for entering the skills students must develop for each project. To complete this chart, break each project into a series of activities and then determine the competencies that will be needed to carry out each one. You may want to create a similar grid to record skills required for each project in the course.

Four Types of Competencies

Keep the following information about the four major types of competencies in mind as you identify them and the content to be learned through each project:

- Technical Competencies

Technical competencies are the processes that someone must carry out to complete a major workplace activity. They include the things someone in a career must know, understand and be able to do; the cognitive processes they must follow to make decisions; and the personal skills they should possess. Do not mistake these competencies for the actions a worker takes in completing a process. For example, "develop a floor plan" may be a major project in a building construction course. "Convert measurements from a scale drawing"—a technical skill needed in developing a floor plan—requires a number of steps to complete. For a student to master measurement conversion, he or she would need to understand certain mathematical concepts and be able to use conceptual skills. (See below for examples of required technical competencies in building playground equipment.)

◆ Supporting Competencies

All projects require **academic, cognitive and personal competencies** as a foundation for applying technical skills. This means that students will need concepts learned in other classes to complete activities. Vocational teachers can enhance the learning experience by working with academic teachers to make sure these proficiencies have been taught prior to or at the time students are asked to carry out a selected activity. Vocational instructors may also need to provide supplemental instruction in these areas.

Cognitive and personal competencies are not the exclusive domain of any teacher. All teachers—including vocational teachers—need to devote extra attention and effort to make sure students master these skills. If students are never asked to think, they do not think. If they are never asked to make judgments, they do not make good judgments. If they are never asked to plan, they do not learn how to plan. If they are never asked to collect information from a variety of sources and organize the information into a plan, they never learn how to do it. If they are never expected to become independent learners, they constantly

Examples of Required Technical Competencies: Playground Equipment Project

- Draw blueprints.
- Know hazards that may occur with various types of playground equipment and how to prevent them.
- Understand fabrication layout.
- Be able to use hand and power tools.
- Be able to identify and compare the advantages of various types of materials for use in constructing equipment.
- Be able to estimate the materials needed and figure the cost of buying them.
- Know how to cut and weld pieces.

Course Project Example

Food Science—Metal in the Kettle

Students in food science classes at West Iredell High School in Statesville, N.C., teamed up to learn and publicize information about the metal residue that various types of cookware leave in food. Food science students prepared omelets in a variety of types of cookware. Students gathered samples of the omelets and other foods and took them to the chemistry lab at the University of North Carolina-Charlotte for analysis. Test results and information about the project were reported in the school newspaper.

depend upon someone else. If they are never asked to manage their time to complete assignments, they never learn how to use time wisely.

Supporting competencies are essential in raising the quality of vocational-technical instruction. They are used by students to complete challenging projects and to work more independently. They also provide a basis for vocational teachers to enlist other instructors in teaching the skills being used in completing projects in vocational courses.

◆ Academic Competencies

Academic competencies can be identified by asking the following questions:

- *Mathematics:* What types of mathematics understandings, procedures and methods of inquiry will be required? Adding decimal numbers? Doing three-place addition? Bisecting an angle?
- *Language arts:* What types of language arts understandings, procedures and methods of inquiry will be required? Documenting progress in an activity? Delivering an oral report? Synthesizing information? Preparing a work plan? Researching technical specifications?
- *Science:* What types of science understandings, procedures and methods of inquiry will be required? Chemical reactions? Mixtures?
- *Social studies:* What types of social studies understandings, procedures and methods of inquiry will be required? Environmental impact? Government regulations?

National standards have been developed in each academic area. Teachers in each subject will be familiar with the standards for their field. Vocational teachers will want to work closely with academic teachers to make sure students apply academic knowledge, understandings and skills appropriately as they complete projects for their career majors. Identifying the required academic skills gives vocational and academic teachers a common language for discussing how they can work together to help students improve performance in academic areas while completing career major projects. By selecting challenging projects that require students to use appropriate academic concepts, vocational teachers can help students meet nationally-recognized academic standards.

◆ Cognitive and Personal Competencies

Cognitive and personal competencies are important for success in all career fields. These skills include creative thinking, decision making, problem solving, reasoning and knowing how to learn. Personal competencies include individual responsibility, interpersonal skills, self-management and integrity. Identify the specific competencies that students will need in carrying out each project you have selected.

Use the Competency Checklist on page 56 to develop a comprehensive list of competencies for each project selected for your course.

Step 5. Develop project outlines.

After projects have been selected and sequenced—and the desired knowledge, understandings and skills identified—the next task is to design an instructional plan for each project. First, develop a project outline that will help you address the essential elements of each project and communicate expectations to students. The outline should be a succinct one- or two-page explanation of the project. Although project outlines can take a number of forms as determined by the type of project and the creativity of the individual teacher, the outline should include the following components:

- **Situation or Problem** — A brief two- or three-sentence description of the problem that students will explore.
- **Project Description or Purpose** —A concise explanation of what the project is expected to be—a product, a process, a research report or a combination of all three.
- **Performance Specifications** — A list of criteria or quality standards that the project must meet.
- **Rules** — Guidelines for carrying out the project.
- **Assessment** — An explanation of how students' performance will be evaluated.

The outline provides guidelines for what students will be expected to do and the circumstances under which they will complete the project. It should describe each project a student will undertake. It should also provide information on quality standards and grading criteria. (See page 75 for one approach to assessing projects.)

Course Project Example

Health Academy—An Anti-Smoking Project
Students in five classes in the Health Academy at Okeechobee High School in Okeechobee, Fla., teamed up in a semester-long preventive health care project in which they learned about the negative effects of tobacco use. They created a pamphlet for school-wide distribution to students, made presentations during the school's televised morning announcements and conducted a survey to determine the impact of the information campaign.

Student ownership of every project is critical for success. Students need to see the project as valuable to them—something that is realistic. Students should be encouraged to become independent learners who can handle challenging assignments that draw upon a range of knowledge, understandings and skills. Students learn and retain more information and produce at a higher level when they—instead of their teachers—do the thinking.

Projects energize students. Use the project outline to involve students at the outset. Students can work with the teacher to plan the project, determine the actions they will take to complete it, list the questions for which they will need answers, and identify potential sources of information. As students develop expertise in a career major, they should be given more freedom to design and carry out projects.

Early on, students should receive guidelines for how they will be evaluated on their projects. They must understand that they will need to do research to determine the sequence of steps to follow and that the teacher will not tell them how to do an activity. Involve the students in developing standards of quality for their work. Also, evaluate the students' creativity in carrying out an activity. *High Schools That Work* research shows that when students are involved in planning and determining quality standards, teachers get far greater response.

A technology education and science project completed by students in the science academy at LBJ High School in Austin, Texas, is an approach that has been used with equal success in classes comprised of inner-city youth with a range of abilities. The project approach seems to work well with students who are turned off by traditional school settings. (See a description of the project in Appendix D.)

(Appendix D contains outlines for a lifting device project, a mechanical engineering project and a playground equipment project. All three projects follow the guidelines discussed in this chapter. Each project outline is organized somewhat differently, but all outlines meet the criteria.)

Develop an outline for each major project.

[illegible] the guidelines in this chapter; include the outlines in

the [illegible] Projects [illegible] of the Course Syllabus [illegible]

In addition to the outlines in this chapter, another outline [illegible]

in the Sample Course Syllabus in Appendix B.

Step 6. Decide on an instructional delivery plan.

After determining goals and outlining projects, develop an instructional delivery plan that will maximize the use of projects and advance students' learning and understanding. The plan will outline the major strategies the teacher can use to manage learning through projects. The analysis of competencies to be taught in conjunction with each project will help you decide on an instructional delivery system.

Quality vocational instruction differs greatly from the lecture/demonstration/lab strategies that have been previously used. The new brand of vocational instruction uses projects to blend the teaching of challenging technical, academic, cognitive and personal competencies. The goal is to help students become independent learners who can plan, conduct research and synthesize information to complete major projects.

Instruction should not focus on leading students through projects planned totally by the teacher or on asking students to complete only those procedures demonstrated by the teacher. Students need to face challenges similar to those encountered in the workplace. They need to learn how to decide what needs to be done and what they need to know to do the job. They need to gather information, develop a plan, do the activity and check whether they did it correctly. Sometimes they need to start over.

In the real world, academic and technical knowledge and understandings are applied in an integrated fashion—not in isolation. They are exhibited naturally as people go about their work. This is how learning should take place in the classroom. New knowledge and skills should be taught when students need

Course Project Example

Business—A Kindergarten Book Project (An integrated project)

Students in English and word processing courses in the Business Academy at Robert S. Alexander High School in Douglasville, Ga., produce books for kindergarten students. They write the stories in English class and use desktop publishing software to lay out, illustrate and produce the books in their word processing class.

them to carry out some part of an activity. It is not efficient or effective to teach technical, thinking, personal and academic competencies as separate entities.

Five steps will guide students as they complete each major activity in a project:

- Define what needs to be done.
- Determine what knowledge is needed to do it.
- Plan how to do it.
- Do it.
- Check to see if it was done well.

This procedure will introduce students to the way knowledge and skills are actually used. Workers in real life are not simply asked to "do it," requiring the use of procedural skills. They are also asked to define, plan and check, using thinking, academic and personal skills and a substantial knowledge base.

A vocational class can be organized as an active learning lab, where students learn from each other, use library resources and the Internet, link to other classes and ask teachers, employers and community experts for help. Students can identify resources within and outside the school. Surveys of parents and employers can turn up a wealth of information about sources of expertise.

When students run into a problem in completing an activity because of a deficiency in an academic area, a vocational teacher can connect students with teachers who can provide the necessary help. If a student is having difficulty collecting and synthesizing information, his or her English teacher can help. If a student is having trouble applying a particular mathematics concept, a mathematics teacher can help. A work site mentor can demonstrate a process or involve students in a task that will help them complete a career activity.

Planning the Instructional Delivery System

Teachers will need to deal with a number of key issues in planning an instructional delivery system around projects:

Course Project Example

Agriculture—A "No Pesticide Use" Project (An integrated project)
Students in agriscience and ecology classes at Okeechobee High School in Okeechobee, Fla., debated a "No Pesticide Use" bill. However, the students' traditional roles were reversed. Ag students—who had been taught to decide on types of pesticides, their benefits and how to apply them—were asked to take a stand against their use. Ecology students—who would be expected to oppose pesticide use—argued in favor of the bill. Communication students were the audience for the debate.

◆ Project Introduction

How will you introduce the project and involve the students? At the outset, show them how the project is linked to authentic projects and problems found in the workplace. Discuss the technical competencies students will acquire by doing the projects.

The teacher can provide a vision of what the students are expected to accomplish. This includes the standards they must meet and what they are expected to produce. One effective strategy is to take students to work sites to see people actually using the product they are to produce or applying a process they will use. The teacher can also show examples of projects completed by former students.

Students can help plan the project as a context for learning a set of technical, work-related proficiencies associated with a career major. They need to know at the outset what types of decisions they will be expected to make and what project characteristics will be prescribed.

◆ How Students Will Work on the Project

For most projects, students will work both in teams and individually. If they work together on a project, each student is responsible for understanding everything the team has done—the steps and the underlying technical information.

Teachers in a mechanical engineering course at one *High Schools That Work* site use an approach that can work equally well in other courses. In the beginning, students work individually on design solutions in the context of project parameters. They then meet as a team to allow each member to present his or her solution. The team chooses the solution it will use by selecting one of the options presented or elements from several options. The instructor reviews the design to ensure that it meets project guidelines. Once the solution is approved, the instructor teaches the required competencies and the students apply them in their designs. This approach gives students opportunities to work independently and in teams in much the same way they will be expected to perform in the workplace.

When students work in teams, a portion of their grade for the project is based on the work of the team and a portion on the portfolios and other presentations prepared by individual students.

◆ Students' Responsibilities

What are students expected to do to complete the project? An important consideration is how much information the teacher will present through lectures and demonstrations and how much students will be expected to find out on their own. A certain amount of lecture, demonstration and practice will be necessary to make sure students can meet standards in carrying out the project. However, if students are to become independent learners, they must collect much of the information on their own.

◆ Using Resources

The use of a wide array of outside resources is important in developing challenging projects that help students become independent learners. As projects are planned, teachers need to decide how they will set them up to enable students to take advantage of many sources of information. How often will students be expected to call upon other teachers for answers to questions? Teachers need to know in advance that students will be contacting them. How will business and industry resources be used? Will job shadowing or visits to local companies be part of the project? Other strategies include using technical manuals and journals, the Internet and school and community libraries to gather pertinent information.

◆ Student Reflection

An important part of teaching for understanding is helping students reflect on what they have done and what they learned from it. Students must be able to synthesize information and draw conclusions. Ask students to keep diaries that document their activities. Give them opportunities to share what they are learning and to use this exchange of information to decide the best strategies for tackling a project. *At the end of each week, ask students to write a critique that answers three questions: What did I learn this week? In what areas do I need the teacher's help to understand? What can I do to increase my learning?*

◆ Reviewing Student Performance

Teachers need to decide how they want students to review what they have learned. In one strategy, the teacher outlines key points during a classroom discussion. Portfolios (discussed in greater detail in Chapter 7) are valuable for helping students record and review what they are learning, including mathematics, science, language arts and technical concepts. Students can also demonstrate their knowledge in front of the class. This process helps students increase their understanding while giving other students information that will help them grow academically and technically.

◆ Helping Students Stay On Course

Keeping students focused on completing quality projects in a timely fashion is important. If students appear to be getting off course, teachers can redirect their energies. The instructional plan should include techniques teachers will use to keep students moving in the right direction.

◆ **Evaluating Students' Knowledge, Skills and Understanding**

Evaluation strategies are determined as the instructional plan is being developed. The strategies include helping students acquire the ability to check their own work. Teachers can review the information on evaluation presented in Chapter 7, determine their strategies and incorporate their decisions into the instructional plan.

(The instructional format guidelines listed below will help in planning an instructional format to meet the vision of a new vocational course. Use the instructional plan worksheet (see page 66) in developing an instructional plan for each project.)

Instructional Format Guidelines

1. Make sure projects are authentic representations of the career major and are not selected because they provide fun and games.
2. Check to see that the projects enable students to achieve all of the course goals.
3. Use quality standards based on workplace expectations and/or formal certification requirements to measure students' performance and knowledge.
4. Help students understand what represents quality work and expect them to check their own work to see if it meets the standards.
5. Use videos, demonstrations and work site visits to interest students and involve them emotionally in the project.
6. Involve students in planning the project within the context of explicit parameters.
7. Make sure the projects require students to synthesize and integrate technical, academic, thinking and personal competencies.
8. Plan to teach content as needed to complete a project.
9. Require students to work and learn cooperatively.
10. Expect students to conduct some of their own research to carry out the project.
11. Devise strategies to help students stay on course throughout the project.
12. Expect students to be able to explain why and how something works.
13. Provide opportunities for students to present what they have learned to the class and to outside groups.

Project Instructional Plan Worksheet

Project Introduction *(Strategies you will use to introduce the project to students)*

How the Work Will Be Carried Out—Technical and Supporting Competencies and Project Performance *(Expectations for student teams and individual students)*

Resources *(Resources that students will be expected to use to carry out project assignments)*

Project Review *(Strategies for making sure students stay on course with the project)*

Project Reporting *(How students will report on or demonstrate project results)*

Project Evaluation *(How students will be evaluated on their work on the project)*

Enter the steps you will take and the framework you will follow in focusing your instruction on projects. Use Section 6 (Instructional Delivery Plan) in the Course Syllabus in Appendix A.

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Chapter 7

Designing a Course: Assessment

Classroom assessment in most vocational-technical courses has been inadequate. Instructors have mistakenly believed that if students could perform the procedural skills, they knew the content. In teaching for understanding, a student does not truly know something until he or she can explain it, analyze it and apply it in various ways.

More rigorous course standards demand better classroom assessment. This chapter will help instructors develop assessment approaches that encourage greater depth of understanding by students. This action is critical, because assessment determines if students can apply technical, academic, conceptual and personal skills during projects and can demonstrate understanding of technical and academic content on written exams.

The importance of assessing students to make sure they have mastered solid academic and technical content cannot be overemphasized. When youth enter the workplace, they are often expected to pass exams showing they have the general academic and technical knowledge needed in the position for which they are applying. These exams are often based on both performance and knowledge.

Recently, a group of students from *High Schools That Work* sites passed the general qualifying exam for technical positions with a telecommunications company. However, only one of four who had completed a course in electricity/electronics passed the technical electronics exam. Students in vocational-technical courses too often watch demonstrations in labs but never master the underlying technical knowledge. When faced with a typical technical exam required for employment, these students do not know enough to pass.

This book cannot provide a full review of the assessment process. However, by following the guidelines offered here, instructors can begin to develop an assessment plan that measures student achievement and course effectiveness.

The four purposes of assessment are to:

1. **Motivate students to meet high performance standards and to become independent learners.** When students know they are expected to meet high standards in completing meaningful work similar to what is expected in the workplace, they respond favorably because they can see the personal benefits.
2. **Determine if students have learned the essential course content so instructors can address any gaps that may exist.** Assessment must address whether the student has learned the essential technical, academic, cognitive and personal skills required to meet course goals. It must be consistent throughout the course so the instructor can help students master content that may not have been learned initially.
3. **Help teachers see whether the instructional plan worked and how they can augment it in the future.** Used effectively, assessment benefits the teacher as much as the student. When students collectively do poorly, it does not mean the teacher needs to lower standards. Rather, it is a clear indicator that new instructional techniques may be needed. When students do well, the instructor can be confident that his or her strategies are effective. Asking students what worked and what didn't is a good assessment strategy.
4. **Determine students' course grade.** Grading is one of the primary purposes of assessment. It is a meaningful way to indicate the quality of work that has been done. Teachers should be tough but fair in assigning grades. Students should understand the expectations and realize that they will be held accountable for meeting them. However, students should also understand that they will have many opportunities to improve their grades. They should know that if they are given multiple opportunities to master the content and still do not meet the course standards, they will fail. Such a policy will say to students, the administration and the public that vocational courses have high standards and demand quality work from students. Students should be expected to apply themselves and take advantage of multiple opportunities to learn. If they are not there to learn, they should enroll in other courses.

Step 7. Develop an Assessment Plan.

Course goals based on national academic and skills standards are the basis for all assessment.

The instructor can determine if students have achieved the goals set forth in the syllabus. As with all other steps in designing a vocational course, effective assessment requires advance planning.

As you begin to develop your assessment plan, it is important to have a clear understanding of everything to be evaluated. Assessment focuses on four major areas:

◆ **Technical Processes and Procedures**

- Can the student perform each major academic and technical competency required to complete the project according to established standards?
- Does the student's product(s) indicate the ability to apply technical proficiency to accepted standards?

This area of assessment deals with how well the student can actually perform and produce products in keeping with course standards.

◆ **Academic Knowledge**

- Does the student possess critical knowledge about technical and related academic competencies used to complete the project?

This area of assessment determines if students have mastered critical concepts they must know to complete the project and if they have learned how to obtain relevant information.

◆ **Thinking and Understanding**

- Can the student apply information, ideas and concepts with meaning and understanding?
- Can the student make a written report and explain verbally what he/she has done and why?
- Can the student analyze a situation and make appropriate decisions about it?
- Can the student solve problems and give a clear rationale for what was done to solve them?
- Can the student collect, synthesize and use information to complete the project?

This area of assessment addresses whether students can integrate the separate skills to complete a project and whether they truly understand what they have learned well enough to write about it, explain it verbally, analyze related situations and apply what they have learned in other situations. This area of assessment is important in helping students become independent learners and workers.

Employees frequently face situations for which there are no written procedures. Good, high-paying jobs go to people who can think, plan, organize information and make judgments concerning the best course of action. Yet, these skills are lacking in many students. **The biggest weakness of student interns involved in a *High Schools That Work* high-tech manufacturing program was their inability to find, organize and evaluate information.**

◆ Personal Development

- Is the student self-motivated and able to manage time?
- Can the student work with and learn from others?
- Does the student demonstrate honesty and integrity?

This area of assessment determines if students are developing the interpersonal, time management and motivational skills needed for success in the workplace.

Getting Started

Keeping in mind the areas to be assessed, the first step in developing an assessment plan is to list the major projects selected for the course. Next, include the technical and related academic, cognitive and personal competencies developed for each project. Finally, include information on how you will measure each competency and conduct an overall summative evaluation of the project.

As assessment strategies are presented in this chapter, you can determine the specific strategies you will use to judge individual qualifications and students' integration of the skills in completing projects. (See page 71 for an outline to use in developing your assessment plan.)

Assessment Strategies

In courses that base much of their content on projects, teachers use a variety of assessment procedures. Written tests are still important to test certain types of factual knowledge, but tools such as demonstrations, presentations, reports and portfolios can also determine if students have truly mastered the critical concepts.

The following section presents a variety of assessment strategies and suggests the areas each strategy is most effective in addressing.

◆ Portfolios

Use portfolios to assess:

- Technical processes and procedures
- Academic knowledge
- Thinking and understanding

Assessment Plan Outline

Project *(List project titles.)*	**Competencies** *(List all competencies.)*				**Strategy** *(Indicate assessment strategies to be used.)*
	Technical	**Academic**	**Thinking**	**Personal**	

Portfolios are a major assessment strategy in project-based courses. They help the teacher determine students' thinking processes throughout each project, the reasoning behind students' decisions and students' abilities to arrive at conclusions and communicate what they have learned.

Equally important, portfolios offer concrete evidence of students' accomplishments to share with parents, employers, educators and other students. A quality portfolio can be a source of great personal pride and an impressive record of accomplishments to show potential employers.

A portfolio is a collection of work that demonstrates a student's knowledge and skills over a period of time. It can take many forms and may be used for a variety of purposes. For this book, the discussion of portfolios will be limited to their use in presenting students' work on projects.

Students will be asked to keep a portfolio throughout the course. The goal is to challenge them to reflect on what they have learned and to show how new knowledge fits together and relates to real-life situations. The portfolio is a repository for everything the student does on projects in the course. It can include a daily log, examinations, writing assignments and evaluation forms. In addition, students will complete specific assignments as part of the portfolio.

Although portfolios can differ from course to course depending upon course goals and student expectations, all good portfolios:

- Require students to reflect on the relationship of new learning to career goals;
- Require students to reflect on their work as they complete each phase of a project;
- Provide a way to evaluate students' work from start to finish;
- Help determine if students understand processes and procedures;
- Ask students tough questions about the relevance of what they are learning.

(See page 73 for more information on portfolios. Similar guidelines can be given to students at the beginning of the course.)

Portfolio guidelines should include directions and criteria for students to follow in assessing the quality of their work before turning it in. The teacher can use the criteria to determine how well the student has grasped the concepts of the project. At the end of each project, the student will turn the portfolio in for evaluation. The richness and quality of the portfolio is reflected in the student's grade.

Students may be asked to make oral presentations based on their portfolios. (The guidelines on page 73 contain criteria for evaluating such presentations.)

Portfolio Guidelines

Now that you have completed your project, **(Name of Project)**, it is important to reflect on what you did and where you might use this new knowledge in the future. You were expected to learn a series of technical competencies in carrying out the project. These skills are listed below: **[Teacher: List all competencies here.]**

Your portfolio should include answers to questions about what you have learned.

- Select three technical skills you learned and explain why each one is important in completing such a project. What would happen if one was left out?
- What piece of information did you learn that was most critical to completing the project? Why do you think it was most critical?
- What academic, thinking and personal skills were critical to the satisfactory completion of this project? Did you already possess these skills? If not, what did you do to acquire them?
- What products resulted from the project? Explain what you did, how you did it and how the products you produced might be used in the workplace.
- List two real-life career situations in which you could apply what you learned. What advantage would you have in these situations over someone who did not learn what you did?

You may use narrative statements, photographs and other illustrations to answer these questions. At the end of the project, you will turn in your portfolio for evaluation.

Criteria for Judging Your Portfolio

These questions will help you evaluate work on your portfolio:

- Do you have an entry in your log for every day?
- Have you included all tests, evaluation forms and writing assignments?
- Did you answer all questions completely?
- Are your responses unique? Do they represent what you think about the activity, or did you just repeat facts you learned?
- Could you apply the information and processes you learned to a new set of circumstances? If you answer yes, explain why you could. If you could not, explain what else you need to learn to do so.

Criteria for Judging Your Portfolio Presentation

You will be asked to make a presentation based on your portfolio. The following information will help you prepare for your presentation:

- Does your presentation flow clearly and logically from one idea to another?
- Does the presentation demonstrate how to use what you have learned in real-life career situations?
- Do you have all the facts straight so that what you say in one place does not contradict something you said elsewhere?
- Does your presentation convey the excitement you felt about what you learned?

Note to Teachers: If you do not plan to include an oral presentation as part of the portfolio assignment, you can eliminate the presentation section of the guidelines before providing them to students. You may want to add other questions to the portfolio assignment section.

✓ Instructional Tips

Portfolios are as individual as the students who produce them. Yet, they must adhere to quality standards as defined in the guidelines. To help students develop outstanding portfolios, instructors can:

- Discuss the guidelines at the beginning of the course and answer questions students may have about them;
- Show examples of outstanding portfolios;
- Stress the importance of a daily journal in answering required questions and preparing oral presentations;
- Help students improve their writing skills by assigning sample exercises that include the types of questions to be answered in the portfolio;
- Encourage students to seek help from teachers, employers and community experts in answering required questions;
- Review portfolios periodically throughout the course and offer suggestions for improvement.

◆ Products

Use products to assess:

- Technical processes and procedures;
- Thinking and understanding;
- Personal development.

Most projects will result in some type of product. Requiring students to produce products is an excellent way to determine if they have mastered the correct processes and procedures. Products are as varied as vocational-technical courses and can include anything from a plan to a large machine. However, some common elements are assessed no matter what the product may be. These elements include:

- **Performance**—Does the product do what it is supposed to do?
- **Quality of craftsmanship**—Does the finished item meet the quality standards of the career major?
- **Economy**—Students are often given a budget for materials to create a product. Did the student stay within the budget?
- **Aesthetics**—Is the product visually pleasing?
- **Creativity**—Is the product original?

Finished products can be exhibited in the classroom, a central location in the school or a public place. Each product will be accompanied by a written explanation prepared by the student.

Assessing Projects

One approach that many instructors may consider radical is to evaluate projects solely on the basis of whether they were completed. Students in a semester-long mechanical engineering class in the Science Academy at LBJ High School in Austin, Texas, are evaluated in this manner. Each student's grade is based on satisfactory completion of a single project designed according to specifications. Students are expected to document their activities as they move through the course's five-step process. The process includes:

1. **Conceptualization** — Students consider various concepts for completing the project individually and then in teams.
2. **Design** — Students work in teams to arrive at what they believe to be the best possible design solution, considering contributions from all team members.
3. **Layout** — Students prepare a layout of the proposed design, including a three- dimensional computer-assisted design of the solution. Each team presents its design solution before a panel comprised of engineers from the community. Based on input from the panel, teams revise their layouts before proceeding to the next step.
4. **Construction** — Each team constructs three functioning devices.
5. **Evaluation** — The project is evaluated based on documentation and the completed prototypes.

The course is intended for ninth-graders with no previous design experience.

Product displays should be augmented by oral presentations whenever possible. These presentations will include an explanation of what the product is designed to do, how the student created it, alternatives that were considered, why he/she did what was done and a demonstration of how the product works.

The teacher can evaluate the products or, even better, organize an evaluation panel of outside reviewers consisting of other teachers as well as representatives of the occupational field for which the product was designed. If an outside panel is used, it is important to give panel members a printed form and uniform criteria to use in evaluating the products. (See page 76 for an example of the type of form that might be used by reviewers.)

✓ Instructional Tips

Products can be produced by students working individually or in teams. If the product is a team effort, each member must make a significant contribution to the group. To help students develop quality products, instructors can:

- Identify technical competencies to be demonstrated;
- Discuss product performance standards before students begin work;

Design Evaluation Form

This form is used by a panel of engineers to evaluate student design products in a mechanical engineering class in the Science Academy at LBJ High School in Austin, Texas. Students make an oral presentation to explain their design ideas to the review panel. They also produce a written report and a three-dimensional computer drawing of the design.

Date____________________ Class Period____________________

Teacher____________________

Engineer Evaluators:	Student Designers:
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

5 = Excellent, 4 = Good, 3 = Needs Some Improvement, 2 = Needs Much Improvement, 1 = Not Acceptable

1. How likely is this design to perform the assigned task?
   5 4 3 2 1
2. How difficult is this design to manufacture?
   5 4 3 2 1
3. How clear, complete and accurate is the drawing?
   5 4 3 2 1
4. How clear and accurate are the set-up and operating instructions?
   5 4 3 2 1
5. Are the cost constraints met?
   5 4 3 2 1
6. Are all specifications met?
   5 4 3 2 1
7. Overall rating:
   5 4 3 2 1

- Direct students to resources that will help them plan and produce a product;
- Review products as students work on them and recommend adjustments when the work does not meet standards;
- Invite employers from related fields into the classroom to discuss product standards and techniques;
- Give students opportunities to visit businesses that develop and/or use the types of products being produced in the course;
- Help students learn to work in teams to simulate and discuss good and bad group process techniques.

◆ Writing Assignments

Use writing assignments to assess students' ability to:

- Analyze processes, situations, products, etc. by breaking them into smaller parts and seeing their relationship;
- Synthesize information learned into a new plan, product or classifying scheme;
- Express major technical and academic principles in their own words.

Many vocational-technical students do not measure up when it comes to communication. The "hands-on" aspect of vocational courses often overshadows the need for students to be able to write or talk about what they are learning. Youth who fail to develop strong communication skills will be hampered in their efforts to enter and advance in the workplace. The ability to write good reports and business letters and to communicate verbally is a requirement in most work settings.

Today, high school teachers across the curriculum are seeking to address the communication shortfall by requiring students to write more often and in a variety of formats. Vocational-technical education must be part of this movement. Vocational-technical courses offer many opportunities for students to complete writing assignments. Three types of writing assignments include:

- **Essays and Research Papers**—Long a staple in language arts courses, essays and research papers are equally appropriate in vocational-technical classes. They are a way for students to learn how to gather, analyze and organize information into a proposal, a plan or an operational manual. Teachers can assign long-term essays and research papers or short in-class essays on topics being studied.
- **Project reports**—All projects are enhanced by some type of writing assignment. Students can be asked to answer questions for their portfolios (as shown in the guidelines on page 73). or to prepare a synopsis of their work

on a project as documented by a daily journal. Students can also be asked to prepare brief interim reports to show their progress throughout a project.

- **Proposal Writing**—Students can develop a proposal for an independent study project. Proposal writing is an important function in the modern workplace.

✓ *Instructional Tips*

Writing assignments are a valuable way to determine if a student has grasped the key technical processes and procedures and the underlying knowledge base. These assignments are even more valuable in determining if the student understands the key concepts well enough to explain and analyze them and make connections. To help students improve their writing skills, instructors can:

- Work with a language arts teacher to make the writing assignment a joint project for both classes.
- Seek the help of a language arts teacher in setting assessment standards for written research reports; in developing a plan, procedural manuals or proposals; and in reviewing completed assignments.
- Give students precise guidelines for format and writing style. Be clear as to where creativity is valued and where it is important to follow established rules.
- Share examples of quality writing assignments.
- Make short writing assignments to help students develop their skills before they are required to complete a longer report.
- Review daily logs and give students immediate feedback to help them improve future entries.

◆ Oral Presentations

Use oral presentations to assess:

- Technical processes and procedures;
- Thinking and understanding;
- Personal development.

Teachers who successfully use projects as the basis of their courses almost always require students to make an oral presentation about a project. These presentations help the instructor determine if students have used the correct processes and procedures, if they understand what they have done well enough to explain it clearly to others and how confident they are in speaking before a group. In the real workplace, employees are often required to talk to customers, colleagues or supervisors about their work. Oral presentations give students an authentic introduction to what it is like to explain a process or procedure to others, especially if the presentations are made before a group of employers.

Presentations can take several forms, including:

- **Demonstrations/exhibitions** — These informal presentations are a good way to help students become comfortable in making presentations. Projects are displayed in a large room. Students explain what they have done and answer questions as guests circulate among the projects. Generally, a student talks to a few people at a time.
- **Realistic simulations** — In this type of presentation, the teacher gives students a problem or situation and asks them to demonstrate how they would handle it. This method is especially effective in determining how students may deal with customers or clients. Students receive immediate feedback from the teacher and can be given an opportunity to re-enact the situation.
- **Project presentations** — Students make presentations about their projects to an audience which can consist of other class members and/or outside guests. It is highly desirable to invite a panel of outside reviewers with expertise in the subject to attend these presentations and to actually score students on their presentations and/or products. (See page 76 for the type of form that can be used for this purpose.)

✓ *Instructional Tips*

- Invite a speech teacher to give students tips on making presentations.
- Make opportunities in every class for students to answer questions and express their views on a subject. Be sure all students—not just the most outspoken—get an opportunity to speak.
- Provide clear guidelines on what the presentation should include.
- Give students a tip sheet on presentation skills.
- Hold a practice session and give students feedback on how they might improve their presentations.
- If outside reviewers are used, share their comments with the students.

◆ Tests

Use tests to assess:

- Technical processes and procedures;
- Academic knowledge;
- Thinking and understanding.

Tests remain an important assessment strategy in project-based instruction. They are especially valuable for testing students on technical content and related academic knowledge. Tests are an ideal way to determine if students have mastered key technical and academic concepts used regularly in many vocational-technical fields. Properly developed tests can also assess students' thinking and understanding skills.

Tests are valuable indicators of whether or not students are progressing. They should be shared with students for self-appraisal in working through a project.

Teachers will want to test students at the end of each unit or project. In addition, students will be expected to pass a comprehensive end-of-course examination on everything they have learned in the course. This exam assesses students' knowledge and understanding of the key technical and academic concepts they have acquired. It should include essay questions as well as multiple-choice and true-false questions to measure student mastery of technical and related academic knowledge. The test can also contain a series of situations requiring students to apply the knowledge and skills they have learned to arrive at a solution.

If time permits, the teacher can organize the class into teams and give them practical problems to solve. Students might work as a team for a day and then take another day to individually write an explanation of the solution.

In any case, students need to know from the outset that the final examination will be rigorous, comprehensive and based on all knowledge acquired throughout the course.

Test Preparation

The two types of test questions—selected-response and constructed-response—should be included in exams. (See page 81 for examples and advantages of each type of test question.)

Constructed-response questions—which require students to demonstrate their ability to draw upon the knowledge and skills they have acquired—have not been used often enough in vocational-technical education. High school classes should help youth learn how to deal with open-ended or unexpected situations that occur in the workplace. In appraisals containing constructed-response questions, teachers look for how well students can:

- Plan;
- Determine materials needed to address a problem;
- Consult proper resource materials;
- Size up a situation and develop a logical process for addressing it;
- Reach conclusions and take action.

Test Questions

Selected-Response Questions

Examples	*Advantages*
Multiple choice	Easier to develop, administer and score
True/false	More efficient use of students' time
Matching items	Strong theoretical basis for judging quality of results
	Good for measuring factual knowledge
	Disadvantage
	Not adaptable to assessing students' ability to synthesize information

Constructed-Response Questions

Examples	*Advantages*
Essay questions	Easier to incorporate real-world settings
	Appropriate for more complex tasks, critical thinking and problem solving
	Better measure of a student's ability to draw upon new and old knowledge to deal with a problem or situation
	Better measure of real performance
Problems presented	Better measure of a student's ability to select and use suitable principles or methods to solve problems

Students in this type of assessment are not tested on whether they can follow a set of procedures or demonstrate their grasp of a specific body of knowledge. To evaluate students' problem-solving ability, teachers give students a thought-provoking problem and ask them to explain how they solved it. Constructed-response questions used liberally in tests can advance students' ability to analyze and synthesize information.

Tests to evaluate students' knowledge and understandings can contain a mixture of both types of question, depending on the uses and advantages of each. You may want to develop a test construction blueprint covering the critical knowledge that students should have learned. (See Step 4 in Chapter 6 for information on identifying competencies and content.) To construct such a blueprint:

- Determine the specific technical and academic knowledge that students need to understand related to the area being tested. List these topics under "knowledge" in the left column of your blueprint.
- Develop test items that pertain to each topic.
- In the right column of your blueprint under "questions," list the number of the test question that addresses the topic. By doing so, you will be sure to develop questions to test each important area of knowledge.

Course Evaluation by Students

At the end of each grading period, teachers can ask students to comment on the process and the teaching methods being used and to offer suggestions for changes that would increase learning. This strategy can help teachers modify their courses to fit the needs of their target group. Business uses this type of input to improve products and services—and there is no reason why education cannot use it as well. Student feedback is essential for improvement.

Research by *High Schools That Work* and other groups has shown that students are bored with their courses and are not challenged or excited by the content they are asked to learn. Half of more than 2,000 students participating in a nationwide telephone survey conducted by Public Agenda said that schools don't challenge them to do their best. Four of 10 respondents said too many teachers do "a bad job." These findings emphasize the need for feedback on what motivates students to do better.

Student assessment can focus on three areas:

- **Self-assessment**—How well did I do on the project or assignment? What could I have done to make it better? What would I do differently in the future?
- **Assessment by other students**—This strategy can be used most effectively when students work in teams. Students can rate each other on projects and oral presentations.
- **Student assessment of the course**—Was the content interesting? Did the teacher involve students enough? What would have made the course better?

A teacher at one *High Schools That Work* site developed a simple questionnaire that she asks students to complete each week. Students answer these questions:

1. What did I learn best this week?
2. What do I still need to work on?
3. What can I change that would improve my learning?
4. What could the teacher have done differently to help me improve my skills?

The responses have been valuable in helping the teacher learn what she could have done differently and where students need help. Even better, she has seen students mature in their views of themselves and become much more responsible as a result of weekly evaluation.

A more involved team evaluation approach is used by teachers in the Sci-Tech course in the science academy at LBJ High School in Austin, Texas. Using a four-point scale, students evaluate themselves and team members in a number of areas. The evaluations are then compared with the instructor's evaluation. If the two evaluations differ, the student's daily log determines which score is accurate. In this course, the student's log is the final word on what the student did. If it isn't written down, it didn't happen! (See the team scoring guide on page 84.)

Grading

Grading is an important part of a vocational course. It provides information to students about how they are doing in meeting the course's expectations.

Too often, students make satisfactory grades in vocational courses by just showing up and staying out of trouble. This standard of performance does not provide a realistic view of what is expected in a career and does not challenge students to meet ambitious goals. It is demoralizing for excellent students to work hard only to find that their grades are the same or scarcely better than those of students who did nothing but show up. At the same time, instructors should not be reluctant to fail students who do not meet the performance expectations of the course after being given multiple opportunities to reach them.

Grades should be based on the quality of the work that students have done to achieve the goals of the course. These goals—and the criteria for assessing whether they are attained—should be clearly outlined in the course syllabus and project assignments.

(See page 85 for an assessment plan that places emphasis on encouraging students to accept responsibility for their own learning and to contribute to and learn from their assigned teams.)

Enter the performance standard you would expect students to achieve
to obtain each grade on the scale.
Use Section 6 (Grading) in the Course Syllabus in Appendix A.

Team Scoring Guide

Student Number and Name:

A ____________________ (self)   Period: ____________________

B ____________________   Teacher: ____________________

C ____________________

Student Performance

4 = Excellent, 3 = Good, 2 = Needs Some Improvement, 1 = Needs Much Improvement

Student Numbers *(Other members of team)*	A *Self*	B *Team member*	C *Team member*	D *Teacher*

Scoring Criteria

Group Participation
Participated in discussion.
Performed designated role.
Did fair share of work.

Stayed on Topic
Paid attention to work.
Assisted the group in staying on task.
Stayed with the group.

Offered Useful Ideas
Gave ideas and suggestions that helped the group.
Offered appropriate criticism and comments.

Consideration and Involvement
Gave recognition and credit to others for their ideas.
Tried to get the group to reach consensus.

Communication
Was easy to hear and understand.
Writes effectively and clearly.

Source: The Sci-Tech course in the science academy at LBJ High School in Austin, Texas

Assessment Plan

Grade	*Scale*	*Criteria*
A	**1-3**	**Independent Learner**
	____	Does research, designs and plans.
	____	Needs little help from the teacher.
	____	Applies academic skills.
	____	Evaluates work and makes adjustments.
	____	Produces quality product(s).
	____	Seeks out and finds resources and learns from other students; contributes to the learning of other students.
	____	Demonstrates knowledge with a grade of 90 or higher on tests.
	____	Develops a quality portfolio.
B	**4-6**	**Semi-Independent Learner**
	____	Does research, designs and plans.
	____	Needs some help from the teacher and other students to develop a plan or design.
	____	Produces quality product(s) with a few flaws.
	____	Needs feedback from the teacher and other students to realize that the project is not up to standards.
	____	Redoes work to meet standards.
	____	Demonstrates knowledge with a grade of 80 or higher on tests.
	____	Develops a better-than-average portfolio.
	____	Makes limited contribution of ideas to the work team and is slow to seek out and learn from other students.
C	**7-9**	**Dependent Learner**
	____	Needs help to research, design and plan or must be given a plan.
	____	Relies a great deal on the teacher and other students.
	____	Must be given procedures for performing tasks.
	____	Requires significant help from the teacher and other students to produce a quality product.
	____	Needs help to evaluate product(s).
	____	Final product is still not up to standards.
	____	Demonstrates knowledge with a grade of 70 or higher on tests.
	____	Develops an average portfolio.
F		**Failure**
	____	Did not complete project.
	____	If project was completed, it was of such low quality that it did not pass.
	____	Failed to document procedures followed.
	____	Did not show criteria for determining quality.
	____	Scored less than 70 on tests.
	____	Produced a poor portfolio or none at all.

Summarizing Your Assessment Plan

The ideas discussed in this chapter will help you determine how to:

- Assess each student's project and performance on the underlying competencies;
- Test overall knowledge through comprehensive examinations at the end of each unit or project and at the end of the course;
- Ask students to evaluate themselves, their team members and the course.

After you select your assessment strategies, you will assign a weight to each one. The weight may vary from course to course depending on the assessment strategies you decide to use. The following sample assessment plan will help you weight your strategies:

Sample Assessment Plan

Assessment Strategy	Description	Weight
Portfolio/Writing Assignments/ Oral Presentations/Student Assessment	Grades on portfolio, all writing assignments, oral presentations, the student's self-assessment and assessment by other students on the team	1/3
Products	Grades on products	1/3
Tests	End-of-unit, end-of-project and end-of-course exams	1/3

Include your assessment plan in the course syllabus you are developing. You cannot include the full details, but you can explain the underlying logic of the plan. List and briefly describe each major assessment strategy; assign each one a weight for the final grade. Include detailed project outlines like the samples in this book. Students need to know what is expected of them to pass a high school vocational-technical course; a comprehensive syllabus will give them the information.

Record a statement of how you will evaluate students in your course

Use Section 7 (Student Evaluation) of the Course Syllabus in Appendix A.

A statement and evaluation criteria are included in the Sample Syllabus in Appendix B.

Rewarding Good Work

Recognition for a job well done is a proven strategy that works with everyone. Students who do quality work should get appropriate recognition. In European technical schools, the walls are lined with students' work. This type of recognition is similar to awarding trophies to football stars and publishing the honor roll in a local newspaper. It says that hard work and outstanding performance will not go unnoticed.

Teachers should seize every opportunity to show examples of students' best work and to talk about what makes it high-quality. A mechanical engineering instructor at Brooklyn Technical High School in New York City invites a large audience of guests into the classroom to observe students' presentations and to provide written evaluations of the projects. The guests include teachers from other departments, students taking related courses, engineers and other business and community leaders and professors and administrators from local engineering schools. Visitors are encouraged to ask questions and to meet informally with students to examine their projects, written reports and logs. The feedback from these guests is positive. As soon as students finish their presentations, they begin asking about the next project!

Conclusion

These are challenging times for vocational studies. Solid vocational courses and engaging career majors can bring focus to high school studies for many students. Vocational teachers can make their courses more challenging, demand more from students and produce independent learners who are destined for success in postsecondary studies and a modern career. The danger is not that vocational teachers will expect too much of students. It is that they will not expect enough!

If you have completed each step in the development of a syllabus as presented in this book, you now have a plan for a course that will be challenging and will set high expectations for students.

Equally important, your syllabus will help educators, students and parents understand that the course can result in a meaningful education. Successful communication of your goals to these key groups is essential if you want to raise standards and help students achieve them. Ownership by everyone will make it possible for vocational teachers to navigate this difficult but highly rewarding pathway.

Appendix A

Course Syllabus Guidelines

Note to Teachers: If you follow these guidelines and the detailed explanations in the book, you will produce a complete course syllabus. This syllabus can be given to school administrators, teachers, employers, parents and students to show them what you expect students to learn in the course. It can help you gain support from other educators, the business community and parents. Above all, it provides clear information to students on what is expected of them.

You may use the information exactly as it is printed or modify it to meet your needs. The italicized text explains in more detail the kind of information you will need to add to make the syllabus complete.

1. Course Description
   - A. **Aim:** *Statement of what students will learn in the course.*
   - B. **Topics to be Covered:**

     ____

     ____

     ____

     ____
   - C. **Place within the Program of Study:** *State if this is a required course for specific major(s). Indicate the prerequisites for the course and if the course is a prerequisite for other courses.*
   - D. **Length:** *Is this a full-year or a semester-length course? How much time per day?*
   - E. **Prerequisites:** *List any courses that students must take before taking this course.*
2. Instructional Philosophy

   This statement will explain the following: Expectations for student performance, how instruction will be delivered, how students will work (independently and in teams), how the community will be used and how students will be evaluated.

3. Course Goals

List major course goals. They should be limited to no more than 8 to 10 statements. The range of goals should reflect basic knowledge, higher levels of intellectual development and procedural skills to be acquired.

4. Major Course Projects

List in order the major projects that students will complete in the course.

5. Project Outlines

Attach project outlines that have been developed for each course project.

6. Instructional Delivery Plan

Describe the steps you will take or the framework you will follow in delivering instruction around the projects.

7. Assessment Plan

Performance Standards

Use the grading scale on the next page, or modify it as needed.

Grading Scale

Grades for the course will be based on the following levels of performance:

Grade	*Performance Standard*
A	**Independent Learner** Did research, designed and planned; applied academic skills; evaluated work and made adjustments; did quality work; needed little help from the teacher; sought and found resources independently; demonstrated knowledge with a grade of 90 or higher; produced a quality portfolio.
B	**Semi-Independent Learner** Did research, designed and planned; needed some help from the teacher; did quality work with a few flaws; needed feedback from the teacher to realize work did not meet standards; redid work to meet standards; demonstrated knowledge with a grade of 80 or higher; produced a better-than-average portfolio.
C	**Dependent Learner** Needed help to research, design and plan or had to be given a plan; relied a great deal on the teacher; had to be given procedures for performing tasks; required significant help to produce a quality product; needed help to evaluate a product; final product still did not meet standards; demonstrated knowledge with a grade of 70 or higher; produced an average portfolio.
F	**Failure** Did not complete projects; if projects were completed, they were of such low quality that they did not pass; failed to document procedures; did not show criteria for determining quality; scored less than 70 on knowledge tests; produced a poor portfolio or none at all.

Student Evaluation

State how students will be evaluated. The statement should list each component that will be part of the evaluation and its relative weight on a 100% scale. Include projects, tests, the end-of-course exam, the portfolio and class participation. You may want to include other items as part of this statement.

Appendix B

Sample Course Syllabus

Course Title: Basic Electronics I

1. Course Description

Students will be introduced to the field of electronics and direct current circuitry. Topics to be covered in the course will include testing and safety procedures; an overview of career opportunities in the electronics field; how to connect and assemble electronic components; trouble-shooting and analyzing electronic systems; analyzing and calculating electronic circuit characteristics, loads and faults; and planning, constructing and trouble-shooting several types of electronic systems. This course is the first of four electronics courses students must take to complete an electronics technology career major and is a prerequisite for the other courses. It is recommended for all students who may want to prepare for further study in a range of electronics fields at the postsecondary level, whether or not the students pursue a career major in high school. It is a semester-length course presented in a 2 1/2-hour block. Algebra I is a prerequisite.

2. Instructional Philosophy

Students will be expected to meet all of the course goals listed below and be able to demonstrate their understanding of the underlying concepts. The instruction will be heavily laboratory- and application-based with a minimum of lecture and demonstration. The course requires extensive student research and completion of experiments and computer simulations. Students will work in teams to complete several projects that enable them to learn how to work independently to plan, construct and trouble-shoot a variety of electronic systems. Assignments will require students to draw upon academic skills in mathematics, science and language arts.

Student assessment will be based on group work, individual completion of project journals and portfolios, project presentations, written reports, tests of students' knowledge of important electronics concepts and demonstrations of important skills. In carrying out projects, students will explain how they thought through the assignment and considered various alternatives to complete the product.

Students will be expected to confer with appropriate business representatives from the community to obtain information for some course assignments. Library research and consultations with teachers from other courses will be required. If necessary, students will be given more than one opportunity to complete assignments to meet course standards, but all students will complete all course requirements at a minimum 90 percent level of specified quality to pass the course. To help meet this requirement, students will learn how to evaluate their own progress and make adjustments as needed throughout the course.

3. Course Goals

Students will learn how to:

A. Follow safety procedures in working with electronic components.

B. Connect and assemble electronic components—including printed circuit (PC) boards—by preparing wire and using solder and pressure connectors.

C. Test, analyze and trouble-shoot systems, using various types of meters.

D. Analyze and calculate various electronic circuit characteristics, loads and faults by using Ohm's law, test meters and scientific calculators.

E. Analyze, reason, plan, construct and trouble-shoot a selected electronics system by participating in a team project.

F. Conduct independent research to identify the range of careers available in the electronics field, select a career and present findings to the class.

4. Major Course Projects

Students will be expected to:

A. Make a simple drawing of the hydrogen atom.

B. Assemble a light-emitting diode circuit.

C. Assemble a wire preparation display board.

D. Assemble a solder and pressure connector display board.

E. Assemble a printed circuit (PC) board and read and record voltage, amperage and wattage loads at indicated points.

F. Prepare a written report to describe heat transfer, melting points, conductivity of wire, composition of insulation and composition of solder and pressure connectors.

G. Prepare a written report on when to use a digital volt meter (DVM) and how to use computer-simulated programs to trouble-shoot circuit faults.

H. Construct a circuit board that includes a simple series, a parallel and a combination circuit, including resistors and points for measurements; and demonstrate understanding of the underlying mathematics concepts using Ohm's law.

I. Research and prepare a brief written report and an oral presentation on a potential career using electronics technology, including how electronics is used on the job, the level of skills needed for employment and advantages and disadvantages of working in the job.

J. Build an audio amplifier or a color light organ as a final project. To complete the project, students will plan, record steps and construct the device; test and record voltage loads at selected circuit points; and produce a written report and make an oral presentation describing how the device operates.

5. Project Outline

Final Course Project - Basic Electronics I

Each student will select a final course project to plan, build and test from two available options: an audio amplifier or a color light organ. Students will be expected to maintain a portfolio throughout the project, prepare a final written report and make an oral presentation to the class.

Objective

Each student will build a project from a schematic diagram provided by the teacher, from raw materials available in the laboratory and with tools and test equipment the student has learned to use in the course. The student will demonstrate satisfactory sustained operation of the finished product. When energized, the circuitry must operate continuously from the designated power source for a period of at least 30 minutes and produce the specified output. For the audio amplifier, the desired output is a clear quality of normal audio output—generally from 50 to 3000 cycles per second. For the color light organ, designated keys must operate assigned color lights.

Building Requirements

The project must fit in a container no larger than 5" x 6" x 10" for the amplifier or 4" x 4" x 8" for the color light organ. The device must be powered by a 9-volt dry cell battery that fits into the container. An on-off switch mounted on the container will energize and de-energize the device.

Other Requirements

A written report on the final project will be prepared and presented orally in class. The written report will include final operating instructions, a wiring diagram, electrical testing procedures and results, project assembly drawings with dimensions in three-view projection and other supporting documentation. Extra recognition will be given for ideas for different applications of the device, design analysis and an explanation of the mathematics and science concepts used in building and operating the device.

Evaluation

The finished project will be evaluated as follows:

- 60 percent for the quality and precision of the final operation of the device. The audio amplifier will be judged on audio clarity and range. The color light organ will be judged on sequencing of light when the keyboard is played.
- 40 percent for the final appearance, use of appropriate procedures and materials, quality of written and oral presentations, ability to work independently and completion of all requirements on schedule.

6. Instructional Delivery Plan

Introduction to project construction and class operation: The teacher introduces the class to exciting applications of electronics and to sample projects completed by former students. He or she asks students to name and describe as many other applications of electronics as possible. The teacher distributes the course syllabus and a list of projects from which students choose enough to fulfill course requirements. Students may propose and—with teacher approval—complete alternative projects that equal or exceed those required for the course. The teacher discusses, demonstrates and outlines safety procedures in laboratory activities and the use of tools and electronic components. He or she outlines class operational procedures, including projects to be completed by individual students and those designed for group participation. Group projects are designed to allow each student to complete each step and learn all of the academic and technical information for that step. The evaluation and grading system is introduced at the beginning of the course to advise students of the standards they will be expected to meet to pass the course and achieve better grades.

Class operation: The teacher provides direction and manages the class but gives students as much responsibility as possible for planning, designing and doing research to complete projects. In brief class assemblies, the teacher lectures and demonstrates particular concepts. The teacher provides parameters for student performance with as many options as feasible. The projects require students to use resources such as technical manuals, journals, computer circuit simulations, resource technicians in the community and other teachers—particularly mathematics, science and language arts teachers. The students maintain progress charts and time lines which are monitored by the teacher.

Monitoring, evaluating and grading performance: Each student is required to assemble a portfolio of knowledge and skills for future reference and reflection. A few thought-provoking questions are included with each project to challenge students to use previously-acquired concepts from mathematics, science, language arts and technology. The teacher conducts periodic class discussions to emphasize key points, check student understandings and prevent gaps in overall progress. Students are called upon to explain selected concepts in class. The evaluation system—which is used to measure qualitative as well as quantitative aspects of student performance—is clearly stated and is explained in the beginning.

7. Assessment Plan

Performance Standards

Grades for the course will be based on the following levels of performance:

Grade	*Performance Standard*
A	**Independent Learner** Did research, designed and planned; applied academic skills; evaluated work and made adjustments; did quality work; needed little help from the teacher; sought and found resources independently; demonstrated knowledge with a grade of 90 or higher; produced a quality portfolio.
B	**Semi-Independent Learner** Did research, designed and planned; needed some help from the teacher; did quality work with a few flaws; needed feedback from the teacher to realize work did not meet standards; redid work to meet standards; demonstrated knowledge with a grade of 80 or higher; produced a better-than-average portfolio.
C	**Dependent Learner** Needed help to research, design and plan or had to be given a plan; relied a great deal on the teacher; had to be given procedures for performing tasks; required significant help to produce a quality product; needed help to evaluate a product; final product still did not meet standards; demonstrated knowledge with a grade of 70 or higher; produced an average portfolio.
F	**Failure** Did not complete projects; if projects were completed, they were of such low quality that they did not pass; failed to document procedures; did not show criteria for determining quality; scored less than 70 on knowledge tests; produced a poor portfolio or none at all.

Student Evaluation

Students will be evaluated as follows:

Evaluation Criteria	*Method of Evaluation*	*Percent*
Daily participation	Attendance, class behavior, participation, lab work	15
Projects	Portfolios, written and oral presentations, quality of finished product	20
Performance	Adequacy of competency performance (technical, academic and safety)	15
Tests	Unit tests on related technical and academic knowledge and practical problems	25
Final examination	Comprehensive knowledge (technical and related academics)and application of knowledge to a typical field related problem or project	25

Appendix C

National Skill Standards

In 1992 and 1993 the U.S. Departments of Labor and Education entered into cooperative agreements with 22 organizations representing a wide range of industries. Each organization would demonstrate an approach to setting voluntary national skill standards. A list of the industries and the organization sponsors is provided below.

In June 1996 the National Skill Standards Board, established as part of the National Skill Standards Act of 1994, awarded nine grants to some of these groups for projects that will serve as living laboratories for a national voluntary skill standards system. These organizations are indicated with an asterisk (*). NSSB is currently awarding grants for the development of standards in 15 sectors. These standards will carry NSSB endorsement. The two grants that had been awarded as of August 1997 are noted below.

For more information about voluntary skill standards, visit the **National Skill Standards Board web site at http://www.nssb.org.**

Skill Standards Projects

Advanced High Performance Manufacturing

Contact: C.J. Shroll, Director
National Coalition for Advanced Manufacturing (NACFAM)
1201 New York Avenue, NW
Suite 700
Washington, DC 20005
Phone: (202)216-2740
Fax: (202)289-7618
cjshroll@aol.com

Air Conditioning, Heating, and Refrigeration

Contact: Victor Harville, Project Director
V-TECS, Southern Association of Colleges and Schools
1866 Southern Lane
Decatur, GA 30033-4097
Phone: (800)248-7701
Fax: (404)679-4556
74507.2026@compuserve.com

Automobile, Autobody, Medium/Heavy Truck Technician

Contact: Patricia Lundquist, Executive Director
National Automotive Technicians Education Foundation (NATEF)
13505 Dulles Technology Drive, Suite 2
Herndon, VA 22071-3421
Phone: (703)713-0100
Fax: (703)713-0727

* **Bioscience** *(Guidelines are being developed using previously created Bioscience and Agricultural Biotechnology skill standards, which will be combined into one set of standards.)*

Contact: Judith Leff, Senior Project Director
Education Development Center
55 Chapel Street
Newton, MA 02158
Phone: (617)969-7100
Fax: (617)332-4318
judyl@edc.org

* **Chemical Process**

Contact: Kenneth Chapman, Head of Technicians Resources/Education
American Chemical Society (ACS)
1155 16th Street, NW
Washington, DC 20036
Phone: (202)872-8734
Fax: (202)872-8068
kmc97@acs.org

Computer Aided Drafting and Design

Contact: C.J. Shroll, Director
National Coalition for Advanced Manufacturing (NACFAM)
1201 New York Avenue, NW
Suite 700
Washington, DC 20005
Phone: (202)216-2740
Fax: (202)289-7618
cjshroll@aol.com

Electrical Construction

Contact: Charles Kelly, Project Director
National Electrical Contractors Association (NECA)
3 Bethesda Metro Center
Suite 1100
Bethesda, MD 20814-5372
Phone: (301)657-3110
Fax: (301)215-4500

* **Electronics** *(This project is developing standards for administrative and information services support personnel.)*

Contact: Cheryl Fields Tyler, Vice President, Workforce Policy and Program
American Electronics Association
5201 Great America Parkway
Box 54990
Santa Clara, CA 95056
Phone: (800)284-4232
Fax: (408)970-8565
cheryl_fields_tyler@aeanet.org

Electronics *(This project is developing standards for entry-level electronics technicians.)*

Contact: Irwin Kaplan, Project Director
Electronics Industries Foundation
2500 Wilson Blvd.
Suite 210
Arlington, VA 22201-3834
Phone: (703)907-7400
Fax: (703)907-7401
margretg@eia.org

Grocery

Contact: Rini Iverson, Administrative Assistant to the
Vice President of Marketing and Education
Grocers Research and Education Foundation (GREF)
1825 Samuel Morse Drive
Reston, VA 20190
Phone: (703)437-5300
Fax: (703)437-7768
natlgrocer@aol.com

Hazardous Materials Management Technology

Contact: James Johnson, Project Director
Center for Occupational Research and Development (CORD)
601 Lake Air Drive
Waco, TX 76710
Phone: (800)972-2766
Fax: (817)772-8972
jjohnson@cord.org

* Health Care

Contact: Sri Ananda, Project Director
West Ed
730 Harrison Street
San Francisco, CA 94107-1242
Phone: (415)241-2712
Fax: (415)241-2702
sananda@fwl.org

* Heavy Highway Construction

Contact: John Tippie, Associate Director for Western U.S. & Canada
Laborers — AGC Education and Training Fund
P.O. Box 479
27055 Ohio Avenue
Kingston, WA 98346
Phone: (360)297-4152
Fax: (360)297-3368
71112.1275@compuserve.com

* Hospitality & Tourism

Contact: Laura Pfalzer, Project Director
Council on Hotel, Restaurant and Institutional Education (CHRIE)
1200 17th Street, NW
Washington, DC 20036-3097
Phone: (202)331-5990
Fax: (202)785-2511
alliance@access.digex.net

* Human Services

Contact: Marianne Taylor, Project Director
Human Services Research Institute (HSRI)
2336 Massachusetts Avenue
Cambridge, MA 02140
Phone: (617)876-0426
Fax: (617)492-7401
marianne@hsri.org

Industrial Laundry

Contact: David Dunlap, Director of Environmental and Regulatory Affairs
Uniform and Textile Service Association (UTSA)
1300 North 17th Street
Suite 750
Rosslyn, VA 22209
Phone: (703)247-2608
Fax: (703)841-4750

Metal Working

Contact: Robert Sherman, Project Director
National Institute for Metal Working Skills
2209 Hunter Mill Road
Vienna, VA 22181
Phone: (703)255-5886
Fax: (703)938-4342
rws100@aol.com

* **Photonics** *(The Center for Occupational Research and Development (CORD) and the Electronics Industries Foundation/Electronics Industries Association (EIF/EIA) are working together to develop a set of integrated standards for technicians who work within the electromagnetic field.)*

Contact: Darrell Hull, Project Director
Center for Occupational Research and Development (CORD)
601 Lake Air Drive
Waco, TX 76710
Phone: 1-800-972-2766
Fax: (817)772-8972
dhull@cord.org

Printing

Contact: William H. Smith, Managing Director
National Council for Skill Standards in Graphic Communications
206 Lafayette Center
Kennebunk, ME 04043
Phone: (207)985-9898
Fax: (207)985-6347
NC-SKL-STDS@cybertours.com

* Retail Trade

Contact: Kathryn J. Mannes, Education Coordinator
National Retail Federation (NRF)
Liberty Place
325 7th Street, NW
Suite 1000
Washington, DC 20004
Phone: (202)783-7971
Fax: (202)737-2849

Welding

Contact: Nelson Wall, Deputy Executive Director
American Welding Society (AWS)
550 NW LeJeune Road
Miami, FL 33126
Phone: (305)443-9353
Fax: (305)443-7559

NSSB Industry Clusters for Voluntary Partnerships

1. Manufacturing, Installation and Repair (Awarded to the National Coalition for Advanced Manufacturing)
2. Retail Trade, Wholesale Trade, Real Estate and Personal Services (Awarded to the National Retail Institute)
3. Business and Administrative Services
4. Telecommunications, Computers, Arts and Entertainment, and Information
5. Restaurants, Lodging, Hospitality and Tourism, and Amusement and Recreation
6. Education and Training
7. Finance and Insurance
8. Construction

9. Agriculture, Forestry, and Fishing
10. Mining
11. Utilities and Environmental and Waste Management
12. Transportation
13. Health and Human Services
14. Public Administration, Legal and Protective Services
15. Scientific and Technical Services

Appendix D

Project Outlines

The following project outlines can be given to students. Although each project is organized differently, all three of them follow the guidelines discussed in Chapter 6.

Manufacturing Major—A "Lifting Device" Project

Situation:

In building and construction as well as in industry, machinery is used to lift and move heavy loads over relatively short distances.

Design Brief:

Design and construct a device that can lift and lower "heavy" objects and place them at specified locations.

Technical Competencies to be Demonstrated:

- Weld steel.
- Finish welds.
- Rivet steel members.
- Design a steel girder.
- Drill steel.
- Assemble pulley systems.
- Calculate structural strength of members.
- Operate equipment safely.
- Assemble.

Specifications:

- The device must be able to lift up to three pounds (the "load").
- Each "load" must be lifted vertically at least five inches before being moved rotationally.
- A hook must be manually attached to—and removed from—the load.
- All controls for vertical movement of the device or its extensions must be located on the same side of the device.
- The part of the device that touches the "ground" may not exceed beyond an 11-inch-square area.

- The device may be free-standing. It cannot be kept from lifting off the ground or from tilting by any attachment to the "ground," wall, ceiling or anything external to the device, including a person.
- The device must have a mechanical advantage in lifting of at least 3.
- All movements of the device must be accomplished with levers, linkages and/or pulleys and belts or simple wheels.
- Only one person may touch the device during its operation.
- All group members must be able to operate the device.

Rules:

- Each "load" will have a hook by which it can be lifted.
- The "ground" will be at the same elevation as the lifting and release locations.
- You will be required to lift and move three "loads" in two minutes.
- The "loads" will be of varying sizes and weights.
- The locations for picking up and dropping off the "loads" will be specified at the time of project presentations.
- The "loads" will be placed for pick-up in locations between six inches and 20 inches from the center of the device's base area.
- The locations for the release of the "loads" will be within 360 degrees of the original pick-up location and from six inches to 20 inches from the center of the device's base area.
- No electrical or pneumatic devices may be used to operate the device.
- A maximum of $10 may be spent by each group to purchase materials.
- Any materials found or supplied by the teacher may be used.
- No prefabricated units or building members may be used to build the device.
- Presentations will be on (date).

Lifting Device
Grading

Scoring

1.	Hook was in position over "load."	20 points each "load"	60 points
2.	"Loads" were placed accurately.	20 points each "load"	60 points
3.	Fastest time for completing operations (within limit)		30 points
	Second fastest time (within limit)		28 points
	Third fastest time (within limit)		26 points
	Fourth fastest time (within limit)		24 points
	Fifth fastest time (within limit)		23 points
	Sixth fastest time (within limit)		22 points
4.	Economy of design (minimal amount of material, by volume, needed to complete the project)		5 to 50 points
	1. Technical Competencies		5 to 50 points
	2. Aesthetics		5 to 50 points
	3. Controllability		5 to 50 points
	4. Creativity (in the use of materials, mechanisms and the design of the device)		5 to 50 points

Maximum points..400

Penalties:

1.	Assistance (per intervention)	Minus 5 to 100 points
2.	Controls not within specifications	Minus 5 to 100 points
3.	Device moves off ground (per violation)	Minus 5 to 100 points
4.	Completion of three operations over specified time	Minus 5 to 100 points

Group Grades Will Be Based on:

1. Design and performance (as specified above);
2. Oral presentations;
3. Written reports (including a group log);
4. Developmental process (including the serious consideration of at least three alternative solutions, testing and modification in an organized and considered manner and the way the group functioned as a unit).

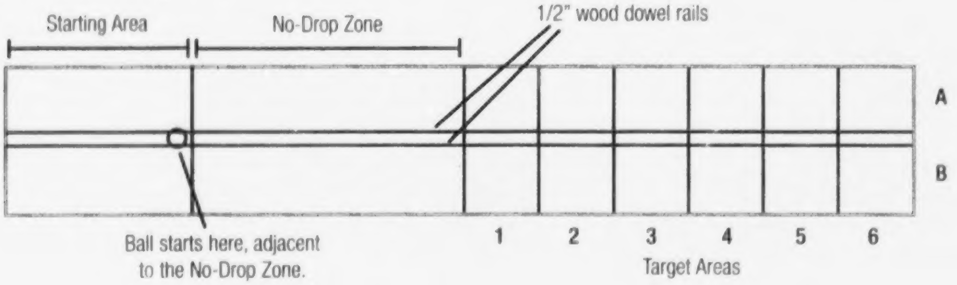
Individual Grades Will Be Based on:

Individual summary evaluations, individual journals and participation in the group.

A Mechanical Engineering Project *

The following requirements must be met to successfully complete the course.

Course Diagram



An actual model is on display in the classroom. The overall dimensions are 6" x 36".

Object

Each team will design a device that will begin in the starting area (6" x 6") and deliver one ball to a target bin (3" x 3") designated at random from a throw of the dice. The two dice will be six-sided: One will have the numbers 1 through 6 and the other will have three A's and three B's. One combined roll of the dice will deliver a random bin number—for example, the result could be B5 or A2—to program the device to deliver the ball. The ball must stay in contact with the rails from its starting position until it goes over the first target bin—essentially, in contact over the no-drop zone (12" x 6"). After that, the ball may be moved to the designated target bin.

Building Requirements

The device must be powered by the elastic potential energy of one mousetrap. (You may use less than that energy total.) Mousetrap energy is the only input energy you may use. The materials for one finished device must cost under $5 (fair market value). The device must be triggered by the fingerprint pad of one finger (triggered only—no input energy supplied by the finger). The overall size of the device must not exceed 6" x 6" x 10" (height) at the starting position (i.e. your device must fit into a 6" x 6" x 10" box before triggering).

Other Requirements

The written design report will include operating instructions (in two languages), a bill for materials, assembly instructions (if assembly is required before operation), a fully developed CAD drawing of the finished device and any other supporting documentation (lab reports, design analysis, mathematics models or other items).

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* This project was developed by science and technology teachers in the science academy at LBJ High School in Austin, Texas.

Evaluation

The device will be evaluated on the consistent and uniform delivery of the ball to the pre-programmed target bin. The operator will determine the target bin by throwing the dice and programming the device for that particular target. The machine must deliver the ball to the target 20 times consistently. The consistency of the delivery time will be based on the average time of function and the standard deviation of the mean of the average time of function. The lower the standard deviation, the better.

Manufacturing Major—A Playground Equipment Project *

Situation:

Skilled workers are often called upon to develop custom equipment to serve unique needs. In this case study, playground equipment is needed for a city park with limited space.

Design Brief:

Students will fabricate and install several pieces of playground equipment on an elementary school campus.

Technical Competencies:

1. Design playground equipment that is structurally sound without safety hazards.
2. Cut pipe.
3. Weld pipe.
4. Drive pipe pilings.
5. Fasten with bolts.
6. Finish pipe.
7. Assemble parts.
8. Cut sheet steel.
9. Fasten sheet steel to rails.

Project Selection

This project may be adapted to the local manufacturing situation. The type of products selected can vary according to community needs (i.e. farming or fishing). Playground equipment was selected because it would produce a product useful to a school.

Community Resources

Related local businesses can supply people to mentor each team throughout the project. The local parks and recreation director can advise the students on how to build for safety and how to obtain the lowest long-term costs. The school maintenance director can discuss maintenance considerations.

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* This outline is adapted from a project developed by the Integrated Curriculum Standards Project staff at the Center for Occupational Research and Development in Waco, Texas, and is used with permission.

Performance Guidelines

Each team will:

- Design, fabricate and install one piece of equipment at a local school to test the concept.
- Select a different muscle group to target with the design.
- Give major consideration to safety.
- Calculate the manufacturing and lifetime maintenance costs to determine the market price.
- Select and present its choice of playground equipment to be installed based on costs and other factors. Team members must be ready to explain the process they followed to arrive at their decisions.
- Prepare an installation/instruction manual prior to installation and present it as part of a group oral presentation to the principal at the elementary school where the equipment will be installed.
- Develop a sales commercial for the product.

Assessment

1. Quality of technical competencies.
2. Safety of equipment.
3. Meeting performance guidelines.
4. Presentation of the design to the elementary school principal.